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INCANDESCENT LAMP TESTS.

THE letter which we published in our last week's issue would have been, in our opinion, but for one circumstance connected therewith, quite uncalled for. We regret to learn that unscrupulous persons have made the results of the Franklin Institute tests a means of disparaging the wares of Messrs. Woodhouse and Rawson; but it is still more to be deplored that these gentlemen did not think it advisable to enter their protest during the progress of the experiments. From time to time in our columns the various stages through which the competing lamps passed were notified, and yet Messrs. Woodhouse and Rawson, in the face of this, and notwithstanding the advice of their American agent that the tests would be unreliable, did not choose to disassociate themselves from the competition until too late.

However, the manufactures of this firm are too well-known to suffer to any extent from what biassed persons may say against them, and, to counteract the effects of such unworthy motives, we shall be pleased to record in our columns the experiences of any users of these lamps who may favour us with the results obtained. Now, leaving the somewhat ill advised protest of Messrs. Woodhouse and Rawson to speak for (or against) itself, we will make a few comments on the methods of testing adopted by the Franklin Institute, methods with which, we think, the competitors who entered for the tests have but little reason to complain. In one, at least, of our contemporaries, strong and weighty reasons have been urged against the employment of the so-called standard candle as a means of comparing the luminosity of the incandescent lamps. If, however, the report of the Franklin Institute had been carefully perused it might have been seen that the Methven standard two-candle slit was used in all photometric measurements, and that this was only verified at intervals by a Sugg standard candle, which is surely within the range of possibility. Ten series of five-minute observations showed only an error of one per cent. as the result of 100 readings. Without going further into the matter of photometry, we are inclined to agree with the Institute Committee that very near exact justice was done.

Mr. Edward Weston, moreover, an authority on all subjects relating to electric lighting and whose opinion we assume carries some weight even in this country, writes to the Committee :—"I am satisfied that the methods used are such as will produce correct results."

Mr. Upton, the representative of the Edison Company, also wrote :—"Having examined the methods of testing used and the results obtained in the efficiency test now being made by the Franklin Institute, I am satisfied that the methods used are such as will produce correct results."

Leaving the lamps of Messrs. Woodhouse and Rawson out of the question, for these apparently should never have been entered (although, be it remembered, all the peculiar circumstances connected with their reception are faithfully recorded in the report), we think that the tests of the Franklin Institute were admirably conceived and very ably carried out, and if, as we learn, there is some chance of complete tests being made in this country, we doubt whether greater precautions can be taken to ensure accuracy than were observed with those which we have thought it but just to defend.

MEDICAL APPLICATIONS OF ELECTRICITY.

IN the *Bulletin de la Société Internationale des Electriciens* for October will be found an interesting paper by Dr. Boudet on the above subject. Adverting to the fact that in the human body we have a series of organs comprising an intelligent system—the brain which commands, the chief mechanician who directs the whole machine; the spinal marrow, an assistant who superintends the functions with which the brain does not occupy itself; and the nerves, which serve as lines of communication between the brain and marrow and the muscles, he states that we have three ways of communication: the motor nerve, charged solely with transporting the impulse which puts in motion the machinery; the nerves of sensibility which signal to the marrow, the assistant mechanician, the wants of the machine; and, finally, the ganglionic nerves, which serve to direct, on the one part, the supply by the arteries of food and materials of maintenance and repair; and, on the other part, the removal of waste by the veins. He continues: Suppose an accident has happened to the machine. A patient cannot raise his fore-arm. It is necessary to ascertain whether the defect is in the brain or in the spinal marrow, in the supply of fuel, in the condition of the muscle machine, or in the transformation of heat into motion. The question is complex; but, thanks to electricity, we can rapidly diagnose the seat of the accident. If the brain be affected, there is no need generally to have recourse to electricity. The means of diagnosis are numberless, and doubt is difficult.

But suppose that the accident has affected another part. An electric excitation is sent directly through the muscle itself, and that responds by a movement as energetic as if the patient had voluntarily moved his fore-arm. That indicates that the muscle is not unhealthy. It continues to transform heat into motion. Its nutrition is intact; the supply of fuel is sufficient; its own sensibility is perfect.

The excitation is carried then to the motor nerve; the movement is still produced. It is not then the motor nerve which is affected, and the defect can be seated only in the marrow. In this case, and when the accident is recent, it often happens that the muscle responds more violently than in the normal state, for it is wanting in the regulator of its functions, and an excitation relatively feeble can determine an energetic contraction.

If, on the contrary, the muscle, excited directly, responds more feebly than in the normal state, we may conclude that it is this, the organ of movement, which is affected, and we should enquire if there is insufficiency in the supply of the materials of nutrition or of combustion. The thing is easy enough, and the information afforded by the medical examination of the patient will put us on the way. It will be quickly known, indeed, if the defect bears an alimentation

with respect to azote or with respect to hydro-carbons. If the former, it is the muscle itself which is insufficiently nourished; if the latter, it is the supply of fuel which is insufficient.

But if the muscle interrogated electrically remains immovable, we can limit ourselves to the examination of the excitability of the motor nerve and of the muscle, and the electric exploration still furnishes a sure reply. The most intense currents from a battery or a coil applied to a nerve completely degenerated will fail to cause the muscle to move. On the contrary, if the muscle be not entirely degenerate, no contraction may be produced by inductive discharges, however intense, whilst a battery current may still provoke a sufficiently energetic movement. Thus the simultaneous use of the inductive and galvanic discharges informs us whether the muscle or the nerve is affected.

The author then proceeds to discuss the remedied applications of electricity, touching firstly on so-called "electrical" methods of treatment, which have nothing in common with this form of energy.

Among those properly called "electrical," he commences with the oldest method known (the "electric bath") by which the invalid is statically charged from a plate machine while on an insulated stool. The action is general on all the nerves of the skin, and sensibility and cutaneous circulation are very quickly re-established in invalids in whom the skin has become dry; and secondary internal reactions are determined which are a great help in the treatment of certain general affections. Thus with anœmics the symptoms of depression or of hyper-excitability rapidly amend when the functions of the skin are regularised. Numbers of women and of delicate girls are thus drawn daily from a condition of organic torpor more quickly and surely than with the use of iron or of other anti-anœmic medicaments.

The electrostatic bath also constitutes an excellent tonic treatment. An invalid afflicted with insomnia is generally relieved on the fourth or fifth day of application.

Static electricity can also be employed locally by means of a point held at a distance from the place to be operated upon, or by means of metallic balls of different sizes. The first method (the "electric wind") is used as a soothing process, is very useful in neuralgia, and often calms the frighful pains of ataxy, and almost always the agitations of chorea, and most of the tremblings which accompany muscular contraction. The second method (by spark) as an exciter can be limited to the surface of the skin to produce a revulsion, as when rheumatism is treated, or can be made to penetrate deep into the tissues to excite paralised or insensible organs.

The author then treats of the application of induced and interrupted currents, and ridicules the indiscriminate use of the pocket induction coils generally met with. For medical electricity two varieties of induction coils can be used. One with a very fine and long wire, possessing high tension and furnishing little quantity; the other made with a short thick wire, giving large quantity with a feeble tension. The first is used to produce a lively revulsion on a point of the skin, most often in the region of a nerve affected with neuralgia, as employed by Ducheum, of Boulogne, and often productive of good results, but always at the price of great pain. The excitation produced by the coil composed of thick wire is to cause muscular movement; its action is quite mechanical, and can be compared to that resulting from a shock briskly applied to the muscle or motor nerve. But this mechanical hammering of the nerves and muscles is not always without inconvenience. The author has observed cases of muscular atrophy, which had been submitted for two or three months to treatment by induced currents, which had resulted in the fatigue and exhaustion of the nervous system and of the muscular tissue. He employs coils of fine wire only to produce a strong revulsion of the skin, and particularly for cutaneous anesthesia. As to those of thick wire, their principal use ought to be reserved for the diagnostic; for therapeutics he substitutes always with success either the galvanic shock or the discharge of the condenser.

The galvanic current certainly affords the greatest variety of applications. With it we can make heat, light, motion, and give rise to numerous combinations and chemical decompositions. A brisk excitation is required to produce muscular motion, and to make it appear it suffices to apply to the motor nerve or to the muscle the discharge of a battery composed of a sufficient number of elements. It is not only an excellent means of exploration but also a valuable method of treatment, free from pain, and permitting an easy estimate of the energy employed.

But the principal applications of the galvanic current are based on its chemical action. If a current be passed through the human body, which constitutes a chemical compound very complex in composition, but sufficiently conductive, chemical reactions are determined which can be stored similarly to those in the accumulator with sulphuric acid. The chemical effects thus produced give rise to new combinations, or rather undergo a transformation of which the definite result is a modification more or less of the nervous force.

The importance of this transformation in remedying muscular atrophy or paralysis is considerable. In the first case the chemical movement operated by the current permits of the muscular machine chemically reconstituting its tissue. After a month's treatment it is often found that the circumference of an atrophial member has gained 0·01 or 0·02 metre. The molecular movement is still easily appreciable in rheumatism, ganglionic tumours, &c.

As to the action of the current on the nervous force, the author does not doubt that it may be the result of a transformation of the chemical effects, similarly as a new current results from the chemical operations produced by the primary current in the secondary battery.

The galvanic current can also be employed to remedy derangements of the entire organism, and very often as good results are obtained as with static electricity. It is by bringing its action to bear on the nervous centres one has a chance of arresting, and even of causing to disappear, general phenomena depending upon a non-destructive alteration which has its seat in the centres of mobility, of sensibility, or of nutrition.

The author touches on an application of great interest to medico-legal experts. Where chemistry is powerless to discover traces of poison, a piece of the corpse is macerated, and some drops of the maceration are injected under the skin of an animal. The symptoms of the animal are then studied, but the evidence afforded is not always sufficient as to the exact nature of the poison. Electricity can furnish more precise means of detecting poison. In animals poisoned with vegetable alkaloids, when the muscles and nerves are electrically excited, it has been found for a certain number of poisons that the curve of contraction provoked by the electric excitation presents a particular and characteristic form. However, there is still a hiatus in the use of this method. If certain poisons furnish a characteristic muscular curve, many others only modify the excitability of the nerve or muscle without changing the form of the curve. Moreover, it is indispensable that the electric excitation preserves a determinate value for all experiments. Up to now neither the direct application of the galvanic battery nor the induction coil could constitute standards of physiological excitation. The use of condensers furnishes a means of obtaining a constant value. The author has by this method obtained curves for a large number of poisons which can be considered as characteristic. The dose of poison and the value of the excitation being indicated, the same curves can always be reproduced by operating in the same conditions. We actually then possess the means not only of recognising the nature of poisons, but also of determining what is attributable to human alkaloids formed spontaneously in the corpse.

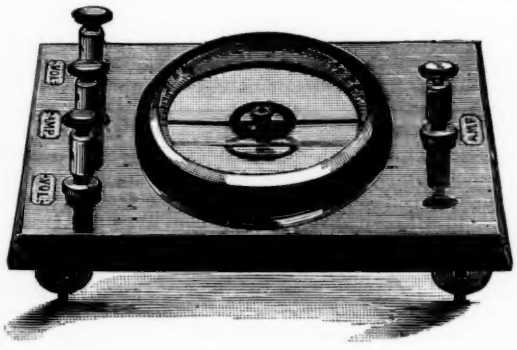
Lastly, the use of condensers permits us to follow daily the results of electricisation for therapeutic purposes. Tables of means indicate, when we first

examine a patient, the state of excitability of his nerves and muscles. With the normal mean such and such an excitation is required to obtain a certain movement. An increase or decrease of this value to produce the desired effect indicates that the conditions are not normal. We see at once how much the excitation is modified more or less, and consequently gather with what we have to do, how the treatment ought to be directed, and what progress is made from day to day.

ELECTRICAL MEASURING INSTRUMENTS.

THE engraving represents the general construction of the ammeters, voltmeters and the volt-ammeters, made under Prof. A. K. Eaton's patent.

The principle of its construction, and the mode of using, are described by the New York *Electrical Review* as follows :—The dark ring outside of the graduated circle is an annular steel magnet, having its north and south poles at opposite points of the circle. The needle is also a thin annular magnet supported in the usual way, with aluminum pointers extending to the graduated circle. The poles of the annular needle are always held in line with the poles of the outer magnetic or field ring, and the effect of terrestrial magnetism is thus practically eliminated. The annular field magnet is adjustable, so that the needle and the pointers upon the movable ring may be made to correspond to the zero of the circle. If it is desired to determine the strength of a current in ampères, the leading wires are



connected with the posts marked "Amp." The current then passes simply through a flat bar of copper beneath the needle. The needle is deflected to a greater or less degree, but is immediately brought back to zero by rotating the annular field magnet. The amount of movement required to do this—which is indicated by a pointer attached to the ring—represents the strength of the current in ampères. The small instrument is generally calibrated, so that 1° shall represent 1 ampère, in which case the full range would be 45 ampères, accurate measurements being limited to a movement of the ring of 45° in either direction from zero. When the instrument is to be used to determine electromotive force the leading wires are connected with the posts marked "Volt," in which case the current passes through a coil of high resistance beneath the needle. The deflection is reduced to zero, as before, by the rotation of the field ring, and this electromotive force, in volts, read by means of the ring pointers. The instrument is generally calibrated, so that each degree represents 1 volt, giving an extreme range of 45 volts ; the rate of reading, however, so that 2° will represent 1 volt or ampère, in which case the range would only be 22½. These instruments may be standardised at different rates of reading to suit any special requirements.

A larger volt-ammeter is constructed on the same principle as the one just described, but is capable of being adjusted at will to any required rate of reading, and to the measurement of currents of very high or very low tensions or current strength. For instance, its range may be varied so that it will measure in one position from one-tenth of a volt to 45 volts, and in another from 1 volt to 450.

MINIMUM E.M.F. IN TRANSMITTING POWER.

THE prominence attained by recent practical experiments in the electrical transport of power justifies the fullest theoretical discussion. Any light that theory can throw upon the subject must be of some value. I shall therefore attempt to make clear, writes Prof. H. S. Carhart in the New York *Electrician and Electrical Engineer*, the question of minimum E.M.F. that can be employed under defined conditions, even at the risk of being too mathematical for some readers.

So far as observed, the discussions of the general problem have proceeded upon the following basis :—Given the E.M.F. of the generator and the resistance in circuit, to find the *maximum* rate of working, or the maximum work that the motor can do. What I propose is, given the resistance in circuit and the work required of the motor, to find the *minimum* E.M.F. This latter is the form in which the matter presents itself as a practical problem. I shall first give the usual solutions corresponding to the former conditions, and then the new solutions with the latter defined ones. In each case R and C denote resistance and current strength, E and E_1 the direct and counter E.M.F. of generator and motor respectively, and W the work done by the motor per second.

First.—Given E and R to find C and *maximum* W.

a. Algebraic solution.—The total energy of the current is divided into two parts, one of which goes to heat the conductor, and the other is absorbed by the motor and converted into useful work. Hence

$$C\,E = C^2\,R + W \qquad (1)$$

The solution of this equation of the second degree is

$$C = \frac{E \times \sqrt{E^2 - 4\,R\,W}}{2\,R}$$

Plainly 4 R W cannot exceed E^2, or C would have an "imaginary" value, which is impossible. W will therefore be a maximum when $4\,R\,W = E^2$. Hence,

$$W = \frac{E^2}{4\,R} \text{ and } C = \frac{1}{2}\frac{E}{R}$$

The current for maximum work is therefore reduced to half the value it would have with the motor at rest, and $E_1 = \frac{1}{2}\,E$. This is known as Jacobi's law. It is not the law of efficiency but of maximum activity.

In the above values W and C are expressed in given terms ; and we have the further deduction that for maximum rate of working, the counter E.M.F. of the motor equals half the direct E.M.F. of the generator.

b. Solution by the calculus.—By transposition of (1)

$$W = C\,E - C^2\,R \qquad (2)$$

Whence $\frac{d\,W}{d\,C} = E - 2\,C\,R = 0$ for the *maximum* value of W, since the second differential is negative. Therefore

$$E = 2\,C\,R \text{ and } C = \frac{1}{2}\frac{E}{R} \text{ as before.}$$

The value of W may be found by substituting the value of C in (2).

Second.—Given W and R to find C and *minimum* E.

a. Algebraic solution.—The work done by the motor is

$$C\,E_1 = \frac{E_1\,(E - E_1)}{R} = W \qquad (3)$$

If W and R are constants then is $E_1\,(E - E_1)$ a constant also. Now when the product of two terms is

constant their sum is a minimum when they are equal to each other. But the sum of E_1 and $E - E_1$ is E, the E.M.F. of the generator. Hence E is a minimum when E_1 equals $E - E_1$, or $E_1 = \frac{1}{2} E$. This condition corresponds to Jacobi's law as might have been inferred directly, because the conditions determining maximum rate of working with a given E.M.F. must also define the minimum E.M.F. required to do a given amount of work.

To determine E and C in terms of W and R, substitute for E_1 in (3) its value $\frac{1}{2} E$, and we have

$$E^2 = 4 R W, \text{ or } E = 2 \sqrt{R W}.$$

$$\text{Whence } C = \frac{1}{2} \frac{E}{R} = \sqrt{\frac{R W}{R^2}} = \sqrt{\frac{W}{R}}$$

b. Solution by the calculus.—From equation (1)

$$E = C R + \frac{W}{C} \qquad (4)$$

Whence $\frac{d E}{d C} = R - \frac{W}{C^2} = 0$ for *minimum* value of E, since in this case the second differential coefficient is positive. Hence

$$R = \frac{W}{C^2} \text{ and } C = \sqrt{\frac{W}{R}} \text{ as before.}$$

Substituting value of C in (4) and

$$E = 2 \sqrt{R W}$$

Also $$C E_1 = W \therefore E_1 = \frac{W}{C} = \sqrt{R W}$$

Therefore $E_1 = \frac{1}{2} E$ as above.

It appears, therefore, that the E.M.F. varies as the square root of the resistance. Hence, if any reduction of E.M.F. is attempted by reducing the resistance, the reduction of the latter must be much more rapid than the former. If R is reduced to one-fourth, the E.M.F. is reduced only to one-half. But the resistance may be increased fourfold by merely doubling the E.M.F., the same amount of work being done with the same efficiency. Whenever attempts are made to work with low E.M.F., as considerations of safety demand, then difficulties at once present themselves. The above discussion shows that with the requirement of a given amount of work to be done by the motor, the E.M.F. has a minimum value which cannot be reduced except by an inordinate and impracticable reduction of resistance.

To apply the results to a concrete example. Assume 20 locomotives on a New York elevated road to represent 2,200 H.P. If the electric motors replacing them have an intrinsic efficiency of 90 per cent., in round numbers 1,800,000 watts of energy must be supplied to the motors per second. If the resistance in circuit is 0·072 ohm, then

$$E = 2 \sqrt{R W} = 2 \sqrt{1{,}800{,}000 \times 0{\cdot}072} = 720$$

and $$C = \frac{W}{R} = 5{,}000.$$

With an assumed resistance of about three-quarters of an ohm the minimum E.M.F. required to transmit to the motors 2,200 H.P. is 720 volts, and the current is 5,000 ampères.

The Electric Light and Health.—At the Parkes Museum of Hygiene, in Margaret Street, Oxford Street, on Thursday, the 10th inst., Mr. Eric S. Bruce delivered a lecture on "Health and the Electric Light," Sir Joseph Fayrer presiding. The electric incandescent lamp, he pointed out, was the only light where they had perfect incandescence without appreciable combustion in the lamp. It possessed all the health requirements of an artificial light, such as an inappreciable heat, purity and brilliancy of colour, steadiness of light, and immunity from danger of fire.

THE DISCOVERY OF ELECTRO-MAGNETISM.

By H. LUTTEMAN, Engineer and Commissary of Swedish Telegraphs.

IN the REVIEW for July 14th, 1883, appears an article from *Cosmos les Mondes*, wherein Dr. Tommasi submits to the managing committee of the then existing Vienna Exhibition these two questions:

"Had Oersted any knowledge of the experiment of Rogmanosi when he published his discovery of electro-magnetism?

"Have any other *savants* taken part in his discovery?"

Having found no answer in the REVIEW to these questions, it may be permitted me to recall them, and to try to clear them up, more especially the first one.

I will set up the assertion that Oersted *had* knowledge of Rogmanosi's experiment; but that he, notwithstanding, is the true and only author of the discovery of electro-magnetism. Moreover, I will insist that Rogmanosi has never, as far as I can see from accessible sources, carried out any experiment proving the dynamic effect of the electric circuit upon the magnetic needle. To that assertion, I will add the opinion that Rogmanosi only worked with static effects of the current.

My assertions are concluded from the following works:—

1. "Historie de la Physique et de la Chimie," of F. Hoefer, 1802, page 209, cited by Dr Tommassi.

2. Professor Tzarn's work on "Magnetism," published at Paris, 1804, in which he cites Rogmanosi's and T. Majon's experiments in Geneva.

3. Oersted's own description of his discovery of electro-magnetism, made in Copenhagen, the 21st of July, 1820.

It is here necessary to recite word for word some sentences from these three works. The translation of Hoefer's description of Rogmanosi's experiment runs in the following words:

"After having made a Volta's pile with discs of copper and zinc, between which were interposed circles of flannel, saturated with dilute ammonia; the author (Rogmanosi) attached to the pile itself a silver wire broken in different places like a chain. He then took an ordinary magnetic needle, disposed in the manner of a naval compass and let it into a prismatic axis of wood. After having removed the glass cover, he placed the needle upon an insulator of glass, close to the battery. He then seized the chain, *taking it by a glass tube, and applied its end to the magnetic needle.* After contact some seconds, the needle deviated several degrees from its polar position.

On removing the chain, the needle preserved the direction thus impressed upon it; on applying the chain anew, it again deviated a little and preserved the position in which it was left, so that its polarity seemed entirely destroyed."

Rogmanosi, to restore it, proceeds as follows: "He pressed with both hands, between the thumb and the forefinger, the edge of the insulated box, but avoiding any shaking, and held it for some moments. The needle was then moving slowly and resuming its polarity, *not all at once, but in successive pulsations*, like the second hand of a watch."

Having read this description of Rogmanosi's experiment, we at once see that he did not work with a closed circuit. If he had done so, why should he have taken such scrupulous precaution to place the magnetic needle upon an insulator of glass, a measure which was quite superfluous in working with the dynamic effects of the current? Why did he catch the wire (do observe the singular number; the other wire was probably put to earth), with a glass tube, if he did not make his experiments with static electricity? That he wished to give the needle a static charge is evident, and it can be concluded therefrom, that, to restore its polarity he desired to make a discharge with the thumb and the forefinger. He also found that the needle did not return at once into the magnetic meridian, but in succes-

sive pulsations after several discharges. This circumstance is a further proof that Rogmanosi worked with a static charge and with an open circuit.

I beg the reader especially to bear in mind the expression "open circuit," because it is, as I will further show, against this technical term and its supposed effects, that Oersted devoted his dissertation, and he consequently must have had knowledge of the treatises of Rogmanosi and other *savants* on this matter.

Rogmanosi thus only observed the static effect of the current, and not the dynamic.

Before we go into Oersted's description of his discovery, we have reason to examine what Tzarn, at Paris, in 1804, wrote about Rogmanosi's and Majon's experiments :

" D'après les observations de Rogmanosi, physicien de Trente, l' aiguille déjà aimantée et que l' on soumet ainsi au courant galvanique, eprouve une déclinaison ; et d'après de celles de J. Majon, savant chémiste de Gènes les aiguilles non aimanteés aquierent par ce moyen, une sorte de polarité magnetique."

We see, therefore, that Majon repeated Rogmanosi's experiment, and besides, that he used a non-magnetic needle, to which he succeeded in giving polarity. Whether these needles were of iron or any other material capable of becoming magnetic, is not known. That he did not transform the non-magnetic needle into a magnetic one, is evident from the fact that Tzarn uses such a reserved and vague expression as "*a sort of polarity.*"

Probably Majon did not desire to give his non-magnetic needle such a heavy charge as Rogmanosi succeeded in giving the magnetic one, and, of course, he only speaks about "a sort of polarity." That this polarity was the result of an electric charge, we have all reason to suppose, because here is nothing which indicates that Majon has used any other method in applying the circuit than that employed by Rogmanosi, who applied *the one end* of the silver wire *to the needle.*

From the descriptions, I think it must be seen that neither Rogmanosi nor Majon worked with a closed circuit, which must have been the condition to gain the honour of the discovery of electro-magnetism.

We will now let Oersted speak, in order to show that he must have had knowledge of Rogmanosi's experiments, and of those of other *savants*, with the open circuit, and to that end it is sufficient to make a verbatim copy of the two first sentences from Oersted's description of his discovery :—

"EXPERIMENTS ON THE EFFECT OF ELECTRIC ACTION ON THE MAGNETIC NEEDLE.

"The first experiments on the subject which I undertake to illustrate, were set on foot in the classes for electricity, galvanism, and magnetism which were held by me in the winter just past. By these experiments it seemed to be shown that the magnetic needle was moved from its position by the help of a galvanic apparatus, and that, *when the galvanic circuit was closed, but not when open, as certain very celebrated physicists in vain attempted several years ago.*"

Having read this description by Oersted himself, we see at once that he must have had knowledge of the experiments of Rogmanosi and other savants who worked with an open circuit. That these savants never succeeded in producing what Oersted did, viz., the magnetising effect of the closed circuit, seems to me to be the prime motive for Oersted's publication of his scientific circular, which was sent to the most celebrated physicists of that time. Therefore, he also in his discovery accentuates the expressions, *circuto galvanico cluso, non aperto*, and he has thereby himself answered the question whether he or any other is the discoverer of electro-magnetism.

To us Scandinavian people who knew Oersted, the religious philosopher, author of the "Soul of Nature," and the man to whom the laws of nature were reason's laws, it is impossible to suppose that this man should have published as his own a discovery which was not his.

I will finish these lines by an extract from the biography of Oersted by the Super-Commissary of War at Copenhagen, C. L. Madsen.

"Eminent as a scholar, he was equally great as a man ; modest and lenient in his judgment of others, strict with regard to himself ; benevolent, always ready to help others with advice and deed ; himself truthful in the highest degree, he demanded truthfulness from others as their first duty."

In such a light Oersted stands to us Scandinavians, and he will keep his glory as long as there is no reason to deprive him of it.

TELEGRAPHING TO AND FROM MOVING TRAINS.

FOR the past few weeks the Phelps Induction Telegraph Company has, according to American contemporaries, been making the surprising statements that they can equip a railroad with their system at an expense of $50 per mile or less, as against $300 per mile according to their previous estimates. Our readers will remember that we described the Phelps induction instruments in our issue for March 7th, 1885. The reason for the remarkable reduction in price mentioned, as explained by Mr. Phelps, is as follows :—

"When we equipped the Harlem River Branch of the New Haven Railroad, about a year ago," said he, "as an experimental plant, there was so much doubt expressed on all sides, as to whether it was possible to accomplish what we intended, that it was thought advisable to spare no pains nor expense in making the plant as perfect in every feature as possible, consequently we used the very best wire, which cost us $150 per mile, and protected it in a wooden box that cost $100 per mile, and the labour amounted to $50 per mile. But after getting the plant in daily operation we were surprised from time to time to find how easily we could maintain communication with the moving train ; how little battery was necessary, ten Bunsen cells being sufficient at the terminal station and two cells on the car. Early last spring I wished to ascertain how much resistance I could insert on the line and still receive from the car. I put six cells of Bunsen battery on the car and connected my resistance box in circuit with the line. I then introduced resistance until I had cut in fifteen thousand (15,000) ohms and still heard the signals distinctly. I could have put in more, but that was the capacity of my resistance box.

"We accidentally discovered one day that we could work to the wire when it was four feet away from the coil on the car, and this discovery led us to believe that it would be possible to work upon the down track, in which case the coil upon the car would be over eleven feet from the conductor upon the other track. By increasing the battery at the terminal station to 30 cells and the battery on the car to 10 cells, we found that it was not only possible but perfectly practical, and for several months past we have been working on both tracks with the wire on only one.

"At a meeting of the directors a few weeks since the question came up whether the high insulation of our conductor might not be dispensed with and an ordinary iron telegraph wire used supported on insulators. The objection to this method naturally was that the snow and slush would at times so impair the insulation as to render the line useless. The result of the discussion was that on the following day Mr. Cheever and myself made some experiments, with a view of ascertaining just how much leak we could allow on the line and still maintain communication with the train.

"We attached a No. 12 copper wire to the main line just as it entered the office and another to the ground wire, bringing the ends of these two wires down to a table in a convenient position to introduce any desired amount of resistance. When the ends of the two wires were connected together, they formed a direct short circuit or shunt around the instruments and batteries in the office and any amount of resistance interposed

in the shunt would represent the leak or wasted portion of the current both in sending and receiving.

"The line between New Rochelle and Haarlem River has a resistance of 100 ohms; the telephone receivers used had a resistance of 70 ohms. We used in the experiment 30 large Bunsen cells at the terminal station, and 11 small Bunsen cells on the car. The transmission both ways was by means of the buzzers in daily use upon the line.

"When we introduced a coil of one ohm in the shunt, all the noise of the line appeared to be shut out and the signals came faint, but very clear and distinct, and could be read as easily as when the whole line was clear. Then we introduced one-half an ohm, and then a quarter, and still the signals were perfectly clear and distinct. We then cut the resistance of the shunt down to one-tenth of an ohm, and still the communication was maintained and messages were transmitted and written down, but it was so faint that it required the expert ear of the operator who was familiar with the sound to catch it.

"We had used as resistance a piece of No. 14 copper wire a few feet long, and as we wished to ascertain the very lowest point to which the resistance could be reduced before communication was entirely shut off, we commenced cutting off the shunt wire a few feet at a time until we had it all out and the ends of the heavy wires were firmly joined together; still the operator wrote down the words that came and the train operator answered his call.

"The wire forming the shunt gave a resistance of one-hundreth of an ohm by careful measurements made afterward, and according to the law of the division of currents, in transmitting from the station to the train only ·0001 part of the current generated by the battery passed over the line, the other ·9999 parts going through the shunt, and in the transmission from the car of the current induced on the line, only one seven-thousandth part passed through the receiver.

"These experiments demonstrated conclusively that insulation is not a very important matter in the working of our system, and we propose now to use only an ordinary telegraph wire, supported by insulators upon the ties about three inches outside and just below the surface of the rail. The insulators will be about 25 feet apart and of a special design. The coil upon the car will be outside the wheels, passing forward on one side of the car and back on the other, so that either side of the car may be turned to the wire.

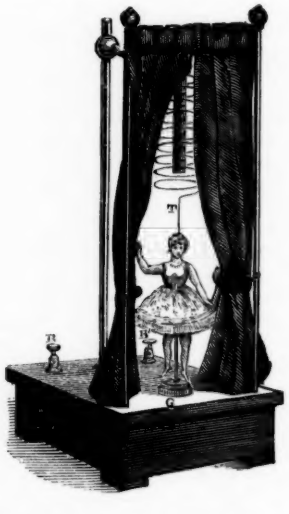
"In this manner a railroad can be equipped with our system as cheaply as an extra wire can be put upon poles that are already standing, and if poles are to be erected, as in case of a new road, it can be equipped with our system at half the cost of a pole line."

SCIENTIFIC RECREATIONS

(*Movable Electric Figure*).

THIS is a charming little electrical toy which we desire to make known to our readers.

It consists of a dancer, or rather a *danseuse*. The figure is suspended from the lower end of a spiral spring, or solenoid, electrically speaking, the axis of which is occupied by a magnetised bar, the whole being supported by a strengthening column. The lower extremity of the spiral spring, T, passes through the figure and terminates a little below the feet of the subject and at about 0·003 m. from the surface of a cup, G, containing mercury. This mercury is in electrical communication with one of the terminals, B, the column which supports the spring being connected with the terminal, B^1. These terminals are connected with a tolerably strong battery (a one litre bichromate bottle cell is enough). The terminals, B and B^1, are suitably marked, so that the poles of the solenoid will agree with those of the magnetic bar which traverses it. The poles of the battery are connected respectively with each of the terminals bearing a similar sign. We charge the battery, we dip the extremity of the wire, T, into the mercury by stretching the spring and release it immediately. Then from the contact, the reaction of the stretched spring, assisted by the attractive action of the coils of the solenoid, produced by the parallel currents in the same direction, causes the figure to rise; then the current is interrupted, for the wire, T, leaves the mercury, the reaction of the spring ceases, the electrical action exists no longer. The weight then



acts, the figure falls again suddenly, the contact is re-established and an ascending action is manifested as before, in consequence of which the same effects are alternately produced, causing the figure to dance more or less rapidly, according to the strength of the current from the battery employed.

The little apparatus is constructed by M. Bassée-Crosse; the arrangement is very simple; the toy itself is consequently inexpensive and has the great merit in our opinion (*La Nature*) of demonstrating the principles of the solenoid and one of the laws of Ampère.

ON IMPROVEMENTS IN GLOW-LAMPS.

By WILHELM SIEMENS.

IN the *Elektrotechn. Zeitschrift*, Vol IV., p, 331, there appeared a table containing the characteristic regarding the then new glow-lamps of the firm of Siemens and Halske. To this table were appended certain explanatory remarks in which the advantages of the new lamps were set forth. A proof was given, indirectly at least, that the augmented efficacy of these lamps was attained not by an increase of temperature injurious to their durability, but by a more judicious treatment of the carbon filaments.

The experience subsequently acquired has merely confirmed the results and views which had then been acquired. The method employed has not merely been retained, but its further development, in which I have to make especial mention of the activity of Herr A. Heller, has led to new and important results.

I give in the following table a conspectus of the types of glow-lamps now manufactured by the firm of Siemens and Halske.

As the unit of light, the English spermaceti-candle has been selected, as is customary. According to the check-measurements performed it consumes hourly, and with a flame of 45 millimetres in height, 7·8 grm. of spermaceti. This loss of weight agrees with other statements. The normal candle is not employed for the current measurements of light, but serves only for the photometry of a glow-lamp selected as a standard light. Its tension is then noted, and is kept exactly constant in subsequent measurements. This standard lamp, however, if in continual use, must be compared

TABLE I.

NAME OF TYPES.	IA.	I.	II.	II.	IV.	IV.	IV.	IV.	VI.	VI.	VI.	VIII.	X.
Light in normal candles	·5	8	10	10	16	16	16	16	25	25	25	35	50
Normal tension in volts	·25	50	100	65	120	100	65	50	120	100	65	100	100
Current in ampères	0·77	0·55	0·39	0·54	0·50	0·53	0·77	1·06	0·75	0·77	1·17	1·12	1·50
Resistance (hot) in ohms	32·7	90·9	256	120	240	189	84·4	47·2	160	130	55·5	89·3	66·6

daily with the normal candle, and must be re-adjusted if necessary, since its light gradually decreases even at constant tensions.

Several Siemens and Halske torsion-galvanometers were used for measuring the current and the tension.

In order to exclude any inaccuracy of the measurements, springing from a possible variation of the instruments, they were compared with a silver voltameter every fortnight in regular rotation. They were also compared daily among themselves.

It may, however, be said, that in spite of the continual use of these instruments for several years, no re-adjustment was found necessary. At the utmost, the table of corrections had to be modified to the extent of half per cent.

To avoid misunderstandings, it may be remarked that the luminous strength of the lamps as here given, signifies their mean horizontal luminous intensity. The measurement of the mean spherical luminosity, which is in itself more accurate, was not carried out on the ground of convenience. Moreover, the mean horizontal strength of light is exclusively used in practice for glow-lamps. Repeated experiments have shown satisfactorily that in the Siemens and Halske lamps, which have carbon filaments of a circular section, one measurement at any angle around the vertical axis is sufficient, and is identical with the mean horizontal strength of light. In the Edison lamps, where the filaments are of a rectangular section, it is sufficient to execute measurements at two different angles around the vertical axis, and to take the mean of both. For the first measurement the lamp is placed so that the two halves of the filament almost cover each other, and for the second, so that the plane of the filament is about at right angles to the axis of the photometer.

A circumstantial discussion of the data given in Table I., would be foreign to the purpose of these communications. It may be briefly mentioned that the favourable results contained in the earlier table above mentioned, as regards the small consumption of energy, and the high resistance of the lamps, re-appear in this new table, and, indeed, partially to an increased extent. Attention may also be called to the relatively very high resistance of the 16-candle lamp at 120 volts, the use of which, *e.g.*, for central stations would admit of a considerable economy in the heavy costs of the system of conductors. This lamp, as well as the types at 65 volts., are especially arranged for installations in which glow-lights or arc lights are worked by the same machine and with one common circuit, which has latterly come into much request. The latter tension in the circuit is requisite when the arc-lamps (those of 3, 6, 9, 20 or more ampères at pleasure) burn singly, parallel with the glow-lamps. The former tension is requisite when the arc-lamps are arranged by twos in succession.

I come now to the method upon which the manufacture of the Siemens and Halske glow-lamps depends, and the application of which permits such important progress.

The method, in itself, is not novel. It consists, in general terms, in a treatment of the carbon filaments in suitable hydrocarbons, and it seems to have first been used by Maxim and Sawyer-Man. As I have previously intimated (*Elektrotechn. Zeitschrift*, March 1883, p. 114), the production of gas retort coke has an analogy to this treatment of the filaments. As here the particles of carbon from the hydrocarbons are deposited on the heated filament, so in the former case a thick, firm layer of carbon is deposited on the hot sides of the iron retort—the so-called retort-carbon. By means of this process, which, without doubt, is in a more or less successful manner the foundation of many modern glow-lamps, it was thought that a greater solidity of the filaments might be attained, and on the other hand, it proved a convenient means for adjusting the lamps with great accuracy to given resistances.

In the treatise already referred to (in the August issue of the *Elektrotech. Zeitschrift* for 1883) I did not enter closely upon the manner of producing filaments on the principle just named. It was, however, distinctly laid down that the main advantage of the new lamps consisted in an improved superficial substance of the carbon filaments, permitting a more favourable emission of light. But that by a correct preparation of carbon filaments in hydrocarbons we might arrive at a more economical quality of eradiation, was a new and certainly not unimportant observation, since in this manner it became possible to produce about one-third more light with the same expenditure of energy, or to work one-third as many more 16-candle lamps than would be possible without this process.

It must be admitted that there is still much scepticism concerning this fact, and that it has remained to a great extent unnoticed. This may be explained by the circumstance that the preparation of the filaments in hydrocarbons does not at once, and as a matter of course, lead to the desired results. I may remind the reader of the observation communicated in Vol. IV., p. 114, of this journal (*Elektrotech. Zeitsch.*), made on some lamps manfactured on the Maxim process. If these lamps were allowed to burn for any length of time at a constant tension, there was found even in a few hours a very notable decrease of light, until finally the lamps burnt quite red. Although even then this defect could be obviated to a certain extent, the results attained were, upon the whole, unfavourable. It seemed, therefore, more advantageous to use carbon filaments without any preparation, as was done in the earlier Siemens and Halske lamps.

Continued experiments gave finally so satisfactory results, that there was no objection to the introduction of the above process into the manufacture, and in the August issue of this journal for 1883 the most favourable data concerning the new lamps could be communicated.

In consequence of the great sale of these lamps, certain experiences and observations were met with in course of time which in the laboratory or in a restricted use might have escaped notice. The practical use of a lamp alone can decide whether it is in all parts correctly combined. An important point, on which practice is expected to supply the decision, is the question of durability. Weighty as is this matter, its value is often exaggerated. A reduction in the temperature of the carbon filaments gives a very easy means of prolonging the life of the lamps indefinitely, though at the cost of economy in other respects. We have here a simple question of expense. In opposition to the cost of procuring the lamps comes the cost of the energy expended in them, and, in the present posture of things, it is more important and economical to reduce the expenditure of energy as far as possible, rather than to prolong their durability beyond 800 — 1,000 hours. Such comparative calculations have been repeatedly undertaken, *e.g.*, at least in a certain sense, by Prof. Dr. Dietrich.

As the basis of his computations he takes the table given by Herr Zacharias in the *Wiener Zeitschrift für Elektrotechnik* (May 15th, 1884, p. 275), showing the durability of the Edison glow lamps when used, not

with their normal tensions, but with greater or smaller ones.

Though Professor Dietrich makes the justifiable reservation that many of the values given seem to him to have been found by interpellation, he considers that a calculation sufficiently approximative for his purpose may be based upon these data.

Against this there is not much to object, if a circumstance of much importance had not been overlooked and which has not yet received due attention. It is known that all glow lamps on prolonged use become somewhat coated, and thereby gradually lose their strength of light. As far as I am aware, the magnitude of this loss and its exact progress have not been at all taken into account.

Many experiments on this subject, conducted in the establishment of Siemens and Halske, have afforded strict proof that we have here a great and general defect of the glow lamp. It has been found that glow lamps after prolonged normal use, *e.g.*, for 800 hours, suffer a far greater loss of light and a far greater decrease of the useful effect, as compared with its initial quantity than might have been expected according to common belief.

The experiments were made in the first place on the Siemens and Halske glow lamps, prepared as heretofore. At first it was feared that there was here a peculiar and inevitable defect of the filaments prepared in hydrocarbons. It could not be denied that these lamps on prolonged use gave out a decidedly duller light than lamps with unprepared filaments. This unfavourable impression was, in part, due to the circumstance that the coating in those lamps had a blackish appearance, whilst in the Edison lamps it took a more brownish character, so that the semblance was worse than the reality.

In any case, it was a matter of pressing necessity to make essential progress in this direction. From the tables and curves given below, it will be seen that the trouble has not been in vain. I cannot give in detail the single stages of the essentially modified and improved process, according to which the Siemens and Halske lamps are now produced. The changes extend almost to every part of the manufacture, so that in reality a quite new lamp has sprung from these experiments. A particularly essential condition of success lay in the production of a vacuum as nearly perfect as possible. A step forwards in this direction is especially Siemens and Halske's patent method of connecting the carbon filaments with the platinum wires. It thus became possible to omit entirely the thickened ends of the carbon, which are so difficult to free from the last traces of air. The connection is now effected by laying the flattened ends of the platinum wires in narrow spirals round the ends of the carbon, not thickened. To effect an intimate connection between platinum and carbon, the point of contact is covered with a galvanic deposit of copper or nickel. It is a condition that the upper turns of the platinum spirals where they lie next to the ignited carbon must remain free from the galvanic deposit. In this manner it is rendered possible that the platinum, in spite of the immediate proximity of the ignited carbon, may not become incandescent, and all danger of volatilisation is avoided.

In order to show the results obtained, I give below some tables illustrated by diagrams, which represent the results of prolonged experiments carefully executed. These experiments extended, in the first place, only to 16-candle lamps at about 100 volts. The lamps were daily in continuous action for about 9 hours. As it was very important to maintain a constant difference of tension at the lamps during the whole time of the experiments, and in order to eliminate as far as possible any irregularities in the movements of the steam engine, an apparatus was introduced into the circuit which maintained automatically an approximately uniform tension in the lamps by the insertion and removal of a resistance into the machine. The greatest difference of tension, transitorally observed in momentary fluctuations of the machine, was three volts.

(*To be continued.*)

REVIEWS.

Lightning Conductors: their History, Nature, and Mode of Application. By RICHARD ANDERSON, F.C.S., F.G.S. Third edition, revised, rearranged, and enlarged. London: E. and F. N. Spon, 46, Charing Cross.

If we examine the list of important buildings struck by lightning since the first edition of Mr. Anderson's work was published, viz., in 1879, we find that the number amounts to 56, including two powder magazines; this record is, doubtless, far from complete, but it is quite sufficient to show the necessity of keeping the public alive to the importance of the subject. The immunity which many buildings, unprovided with conductors, seem to possess from destruction, no doubt powerfully influences those concerned, and suggests the argument that what has not happened for a very long period is not likely to happen at all. Such reasoning, combined with the reluctance which churchwardens and others have to incurring even small expenses, has, in very many instances, resulted in a great number of churches and buildings being left to take their chance of escaping injury at some future date. The literature on the subject of lightning conductors is so extensive that one would think that comparatively little remains to be written; with few exceptions, however, the books do not deal with the matter in a sufficiently full and practical manner to enable the conductors to be properly erected. Mr. Anderson's book is certainly not open to this stigma, as the information furnished is in all cases very much to the point. The first edition was decidedly praiseworthy, but the third edition is a distinct advance on the first.

Examples of Exercises given in the Natural Philosophy Class of Glasgow University from 1865 *to* 1885. *With Indications how to Answer Them.* By M. MACLEAN, official assistant to the Professor of Natural Philosophy in the University of Glasgow. Glasgow: James Maclehose and Sons.

Mr. Maclean's small book of "Examples" (60 pages) is of a class of which we wish there were many more. We have the questions given and the necessary details showing how the answers are arrived at. We notice, however, that several of the questions (though comparatively a small number) are not dealt with; this is a pity, as if this defect were remedied the work would approach perfection. As it is we can most heartily recommend it, though there are a few errata which require correction.

ELECTRICITY IN WARFARE.*

THE first practical plan for using electricity in warfare was devised and executed by Colonel Samuel Colt, the inventor of the revolver, who, in 1841, wrote to President Tyler, stating that he had invented an apparatus by means of which he could destroy in a moment the most powerful man-of-war, even though miles away, and asking that the Government give him opportunity for demonstrating the truth of his statement.

The truth of his statement he demonstrated a year later by exploding a "torpedo" under water, in New York harbour, by means of electricity. Following up this success, he totally destroyed, by similar means, an old gunboat named *Boxer*, and six weeks later, in sight of the President, General Scott, and others, he destroyed a schooner in the Potomac, distant five miles. Congress at once appropriated $17,000 to continue his experiments and perfect his apparatus; and in two months from this time he blew up the big *Volta* in New York in the presence of 40,000 spectators. All of these vessels were at anchor; but in the spring of 1843 Colonel Colt demonstrated the further value of his invention by blowing up a vessel while under way in the Potomac, he being at Alexandria, five miles distant.

These performances seemed, in that day, little short of magic, and their practical value was evident to many, yet they stopped

* Lecture delivered before the Franklin Institute, November 13th, 1885, by Lieut. B. A. Fiske, U. S. Navy.

short at this point and were never resumed. Colonel Colt endeavoured to get further assistance from the Government, but without success. From a variety of reasons the authorities regarded his plans with disfavour, and Colt, disheartened and distressed, was compelled to abandon his invention just at the time when its success was assured but its details unperfected.

But the Russians caught his ideas, and in the Crimean War we find the harbour of Sebastopol defended by torpedoes, many of which were operated by electricity. A few years later, in our Civil War, the electrical torpedo was extensively used by the Confederates in the protection of their harbours. In the Franco-Prussian War, torpedoes were so successfully employed in the defence of harbours that hostile ships did not even attempt to enter them; and in the Turco-Russian War, the mere suspicion that a harbour was defended by torpedoes was enough, in many instances, to keep a hostile fleet at a surprising distance—for the hostile fleet could not know just how far beyond a harbour the torpedo defence extended.

Since the experiments of Colonel Colt the electrical torpedo has gradually improved, keeping pace with the progress of the sciences of electricity and engineering. Yet the original plan is the basis of the most elaborate and perfect instrument, and to the brain of Colonel Colt we owe the surest defence we have for the cities and harbours of our extensive coast.

At the present day an electrical torpedo consists of a strong, watertight vessel of iron or steel, which contains a large amount of explosive, usually gun cotton, and a device for detonating this explosive by machinery; and the most important form is that form which is anchored in a channel, and which is made to explode when an enemy's ship passes near it. These torpedoes are usually called "submarine mines."

In our war, most of these torpedoes were not operated by electricity, but by mechanical means, which consisted, for the most part, of levers protruding outside the case, and so connected with the explosive inside, that when a lever was struck by a passing vessel a hammer inside was caused to fall upon a cap, just as when the trigger of a musket is pulled, a hammer is caused to fall upon a cap. These mechanical torpedoes were used with considerable success by the Confederates, and they caused tremendous damage to the Union ships; but they had a number of defects, on account of which they have been almost entirely supplanted by the more complete, though much less simple, electrical torpedo.

One of the defects of mechanical torpedoes was the danger attending the operation of planting them, another was the danger attending the operation of raising them, another was the fact that it was impossible to tell whether they remained in order, save by the expensive and suicidal plan of seeing if they would explode; and still another defect was, that a mechanical mine did not know a friendly ship from a hostile one, but would sink either with absolute impartiality.

Now, it is clear that an electrical torpedo is free from all these defects, because it cannot be exploded unless a current of electricity be sent through it from a battery on shore or on board ship, so that the only thing to do when it is desired to make it harmless is simply to disconnect the battery; and when it is desired to put the mine into operation again, the only thing to do is simply to reconnect the battery; moreover, the condition of the mine can at any time be determined by sending a very minute current through it, even though the torpedo be miles away, and buried in water many fathoms deep.

In order to understand how electricity can explode a torpedo, it is sufficient to know that when a current of electricity goes through a wire it heats it to some extent, and if the wire be small enough, the heat produced is sufficient to make the wire white hot. Clearly, if powder or fulminate of mercury be in contact with a white hot wire, the powder or fulminate will be ignited, and if this powder or fulminate be enclosed in a tight vessel, together with powder or gun cotton, a tremendous explosion will ensue. Therefore, in order to explode a torpedo, the only thing necessary is to send a current of electricity through a very small wire, preferably of platinum, which is within the torpedo and in contact with the explosive.

That part of a torpedo which includes this small wire and its connections is called the fuse. In practice, the fuse is a separate thing, and is screwed into the torpedo case, the wire from the battery coming in through the fuse through a water-tight gland, so that, after the fuse has been screwed in, the torpedo, as a whole, is water-tight, and may be left under water for months without injury. If the explosive charge is wet gun cotton, as is now usually the case, the fuse contains fulminate of mercury, and is surrounded by a small charge of dry gun cotton. The heat of the fuse wire explodes the fulminate, the explosion of the fulminate causes the instant explosion of the dry gun cotton, and this, in turn, causes the instant explosion of the whole charge of wet gun cotton in the torpedo.

But it is evidently not sufficient to be able to explode a torpedo; we must also know when to explode it, that is, we must know when the hostile ship is in such a position that she will be destroyed if the torpedo is exploded. Clearly, we can know this if we have a chart showing the exact position of each torpedo, and have also an arrangement by which we can know at any instant the bearing of a ship coming up the channel from two stations properly situated. If the ship comes into such a position that she is in the line of one of the torpedoes as seen from each station, she is clearly on the intersection of those lines, and is therefore directly over that torpedo, and the only thing necessary is to touch the electric key controlling that torpedo, thus sending an electric current through its fuse and causing its instant explosion. Another way is to have the telescopes at the two observing stations so fitted that when both point at any torpedo the current is automatically sent through that torpedo. Therefore, if the observer at each station keeps his telescope bearing on an advancing ship, electricity will do the rest, and the ship will sink when she comes within the radius of destructive effect of any one of the torpedoes.

But what can be done at night, or in a dense fog? Evidently these systems will not answer then, because a ship cannot then be seen, and for this reason torpedoes now are frequently made absolutely automatic, so that whether the time be day or night, clear or foggy, the mere fact of a ship's striking a torpedo is sufficient to insure her instant destruction. This result is secured by the use of what is known to electricians as an automatic circuit closer, that is, a device which, when subjected to certain conditions, automatically bridges over the distance between two points which were separated, thus allowing the current to pass between them. In submarine torpedoes it is usual to employ a small weight, which, when the torpedo is struck, is thrown by the force of the blow across two contact points, one of which points is in connection with the fuse, the other in connection with the battery, so that the current immediately runs over the bridge thus opened and through the fuse. In practice, these two contact points are connected by a wire, even when the torpedo is not in the state of being struck; but this wire is of such great resistance that the current is too weak to heat the wire in the fuse. Yet, when the weight above mentioned is thrown across the two contact points, the current runs across this bridge instead of through the resistance wire, and is then strong enough to heat the wire in the fuse and explode the torpedo. Now, the advantage of having a wire of high resistance between the contact points instead of having no wire between them, is that the current which then passes through the fuse, though too weak to fire it, shows by its very existence to the men on shore that the circuit through the torpedo is all right.

But instead of having the increased current, caused by striking the torpedo, to fire the torpedo directly, a better way is to have it simply make a signal on shore, and at the same time throw in a firing battery. Then, when friendly vessels are to pass, the firing battery can be disconnected, and when the friendly ship bumps the torpedo the working of the signal shows not only that the circuit through the fuse is all right, but also that the circuit closer is all right, so that, had the friendly ship been a hostile ship, she would certainly have been destroyed.

The action of a torpedo placed in a harbour and connected by a submarine cable to an electric battery on shore, is thus shown to be quite a simple thing. But it should not be gathered from this that the protection of a harbour is a simple thing, or one that could be accomplished in a few days on the outbreak of war. It should be remembered that each torpedo contains from 100 to 1,000 pounds of gun cotton, that hundreds of torpedoes will have to be used, that the amount of gun cotton required will be enormous, and that it will be wanted in a hurry, but that the operation of making gun cotton cannot be hurried; it must be remembered that to make the torpedo cases required will consume much time, that the making of the fuses is a matter requiring the greatest possible care and calculation, that the operation of properly laying down these heavy, yet delicate, torpedoes in deep water, even in the best possible weather, is an operation requiring great nautical and engineering skill and practice. Yet, even after the best system of submarine mines has been laid down, it will be of no use, unless an enemy's boats can be kept from countermining, and unless the operating rooms be furnished with the best instruments and thoroughly protected against capture, by fortifications, guns and ships. It is no uncommon thing to hear men of intelligence airily say, "Oh, in time of war we can defend our harbours by torpedoes." I do not think I am exaggerating when I say it would take a year to put the torpedo defences of our harbours into proper shape, even if Congress were to appropriate the money to-morrow. And, after that, a corps of men would have to be formed and thoroughly trained in laying down and taking up torpedoes and cables, making splices in submarine cables, testing circuits, managing electric batteries, &c., &c.

In order to detect the presence of torpedoes in an enemy's harbour, an instrument has been invented by Captain McEvoy, called the "torpedo detector," in which the action is somewhat similar to that of the induction balance, the iron of a torpedo case having the effect of increasing the number of lines of force embraced by one of two opposing coils, so that the current induced in it overpowers that induced in the other, and a distinct sound is heard in a telephone receiver in circuit with them. As yet, this instrument has met with little practical success, but, its principle being correct, we can say with considerable confidence that the reason of its non-success probably is that the coils and current used are both too small.

Besides these stationary torpedoes or mines anchored in harbours, there is another class, called spar torpedoes, which are carried on spars protruding from ships or boats, and which consist, for the most part, of cases of steel holding about 30 pounds of gun-cotton, and fitted with electric fuses similar to those for exploding submarine mines. The torpedo on the end of the spar is connected by insulated wires with an electric battery in the boat or ship, and it is designed to be shoved under a hostile ship by a determined effort and exploded there. The current is sent through the fuse by pressing an electric key at the proper moment, or a simple automatic circuit-closer may be put inside the torpedo, so that when the torpedo strikes the ship a break in the circuit is automatically bridged over in the torpedo, thus

allowing the current to heat the platinum wire in the fuse and explode the torpedo.

Still another class of torpedoes are movable torpedoes. These contain not only explosive and means for exploding it, but also machinery for moving the whole through the water, and for steering it. A movable torpedo is, therefore, really a torpedo boat and torpedo combined. In one class of movable torpedoes, such as the lay torpedo, the motive power is usually carbonic acid gas or compressed air, the steering and firing being done by electricity. One wire usually suffices, a simple step-by-step device accomplishing the operation of sending the current through different circuits in the boat, the current through one circuit causing the throttle of the engine to open, the current through another causing it to close, another putting the helm to starboard, another putting the helm to port, another firing the torpedo, &c. Therefore the operator on shore or on board ship can, by moving his switch in the proper manner, cause the torpedo boat to go ahead, stop, turn to the right or left in such a way as to go directly toward the object of attack and then explode in contact with her bottom.

In another class of movable torpedoes the electric current not only steers the boat, but also propels it, there being an electric motor (or engine) inside, which, when supplied with the requisite current from an electric machine on shore or on shipboard, revolves rapidly, thereby causing the propeller of the boat to revolve, in the same way that a steam engine causes the propeller of a steamboat to revolve. The current for steering may either be sent along a separate wire, which may be inside the other one, or a device may be used by which one wire will suffice for everything.

Movable torpedoes being usually cigar-shaped, so that their section is circular, or nearly so, the electro-motor for an electric movable torpedo which will most nearly fit the space intended for it—in other words, the shape which permits the largest size for a given space—is clearly one in which the distance from the centre of the armature to the outside of the magnets is constant, so that the field magnets form nearly a circle embracing the armature. The exterior form of the motor called the Griscom motor evidently seems to fulfil this condition well. The most successful movable electric torpedo thus far tried is the Sims torpedo, with which experiments have been conducted under General Abbot's superintendence for some time, and with very good results. Now, as all men-of-war and all forts are to be supplied with means for generating electricity on a large scale, it is clear that an electric movable torpedo can be easily adapted to naval and military requirements, the mechanism of the torpedo being exceedingly simple, and the only thing to be done to put it into operation being to connect it to a suitable electric machine, and introduce a keyboard, by which the direction and strength of the current can be controlled. The torpedo will then be ready to move at any instant, and will have a supply of power practically inexhaustible.

Recent experiments in England have shown that the Whitehead torpedo—over which control ceases after it is fired—is not so formidable a weapon when fired at a ship under weigh as many supposed, for the simple reason that it can be dodged. Now, an electrical torpedo, over which control is exercised while it is in motion through the water, cannot be dodged, provided it be given sufficient speed. For effective work against ships capable of steaming fifteen knots per hour, the torpedo should have a speed of twenty knots. Now, there is no theoretical difficulty in the way of doing this, for a speed of 11 knots has already been recorded, though an electric torpedo, to get this speed, would have to be larger than a Whitehead having the same speed; and it may be conceived that a torpedo carrying, say, 50 lbs. of gun-cotton, capable of going 20 knots per hour—so that it would pass over a distance of 500 yards in 45 seconds, and yet be absolutely under control all the time, so that it can be constantly kept pointed at its target—would be a very unpleasant thing for an enemy to meet.

Our civil war introduced another use of electricity into warfare, and gave birth to the art of military telegraphy. At first, the telegraph was used only in communicating along the regular telegraph routes, but eventually a corps of military telegraphers was formed, and instant communication became possible between detachments in the field. The advantages of the telegraph in conveying information and orders with despatch was found to be so great that foreign nations took the hint, and to-day a telegraph train is essential to all armies. No well-equipped force in the world is without means for rapidly connecting by the telegraph different headquarters with each other, and with the different parts of an army; and in the Franco-Prussian war it was the telegraph, combined with the railroad, which made possible that wonderful speed and certainty of mobilisation and manœuvre that caused the swift destruction of the armies of France.

In military telegraph trains, miles of wire are carried on reels in specially constructed waggons, which carry also batteries and instruments, some of the wire being insulated, so that it can rest on the ground, and thus be laid out with great speed; while other wire is bare, and is intended to be put on poles, trees, &c. For mountain service, the wires and implements are carried by pack animals. Regularly trained men are employed, and they are drilled in quickly running lines, setting up temporary stations, &c. In the recent English operations in Egypt the advance guard always kept in telegraphic communication with headquarters, and with England; and after the battle of Tel-el-Kebir, news of the victory was telegraphed to the Queen and her answer received in forty-five minutes.

The telephone, also, has been used in military operations, and with great success; having an evident superiority over the telegraph for some purposes. One use of the telephone, in fact, is to assist the telegraph in cases where by reason of the haste with which a line has been run, the current leaks off, so that the receiving instrument will not work. The only thing necessary is to use a telephone to receive the message, and to use as a transmitter a simple buzzer, or automatic circuit breaker, controlled by an ordinary key. In many cases, where the ordinary receiving telegraph instrument refuses to work, the more delicate telephone thus used will work very satisfactorily.

In endeavouring to use the telegraph and telephone for strictly naval purposes between ships, a number of obstacles have been met which have not yet been overcome, though many ingenious devices have been attempted. It might seem at first sight as if, in the case of ships at anchor, telegraphic and telephonic communication among the ships and between the ships and shore would be an easy thing to establish. It is easy, and it has been established in the case of ships moored so that they cannot swing; but when a ship swings by a long chain, most of which is embedded in the mud, it becomes very difficult to devise an automatic means to keep the wire from being fouled and broken.

In England, in the case of lightships, the difficulty has been surmounted, or rather avoided, by making the cable by which she rides hollow, and running an insulated wire along the long tube thus formed inside. This plan has been found thus far to work very well, even in the worst sort of weather.

But the problem is much simplified when temporary communication only is desired between ships at anchor, between a ship and the shore, or between a ship and a boat which has been sent off on some special service, such as reconnoitering, sounding, &c. In this case, portable telephones are used, in which the wire is so placed on a reel in circuit with the telephone, that communication is preserved, even while the wire is running off the reel.

The telephone has been used to some extent on shipboard for communicating between different parts of the same ship, giving orders to the magazines, battery, &c. The vibration of a ship is seldom so excessive as to impair the working of the microphone transmitter; and, in cases where it is excessive, the original magneto-transmitter has been found to work perfectly, getting rid entirely of trouble due to vibration, and at the cost of only a little of the loudness of tone as heard in the receiver.

The telegraph and telephone are both coming largely into use in artillery experiments and drills, as in tracking a vessel as she comes up a channel, so that her exact position at each instant is known, in determining the spot of fall of a projectile, &c. In these cases, two observers, at the ends of a base line electrically connected, know at each instant the bearing of the vessel or the projectile from both ends of the base line, and the intersection of these lines of bearing is, of course, the position of the vessel or the projectile at that instant. In the case of a vessel, this gives the range for the guns, and in the case of a projectile, it shows by how much the projectile missed the target. In getting the time of flight, also, of projectiles, electricity is of value, since it enables the observers to get the exact time of start, a thing impossible to get with stop watches; but by making the projectile break a wire in circuit with a chronograph, the precise instant of start, to a thousandth of a second at least, is automatically registered.

An application of electricity, somewhat analogous to this, has been in use for years, in what are broadly called velocimeters, that is, instruments for ascertaining the velocity of projectiles. There are scores of patterns, but in all wires are cut by the projectile at different points of its flight, and the breaking of each wire causes the breaking of the electric current going through it, and this causes the appearance of marks on a surface moving along at a known speed. Now, knowing the rate at which this surface moves, and observing the distance on the surface between the marks caused by the breaking of the first wire, and the marks caused by the breaking of the second wire, we can compute the interval of time which elapsed between breaking of the two wires; and now, knowing this interval of time, and knowing also the distance between the two wires, we can calculate at once the velocity of the projectile in going from one wire to the other.

Within the past few years electricity has come to be employed to a great and increasing extent in firing great guns, both on ships and in forts.

In the case of ships the advantage of electrical firing lies in the fact that a gun can be fired more quickly by electricity than by other means. The ordinary means of firing are, as is well known, percussion and friction, and in each of these systems the moving parts have to be of such strength that considerable force must be exerted by the arm, in order to operate them. Moreover, for prudential reasons, the line leading to them from the hand must be kept very slack, lest a lurch of the ship should cause such a movement of the man's body as to bring a strain on the line sufficient to cause the accidental firing of the gun. Therefore, when the gun captain finds the sights on the gun bear on the target he must then move his arm through a considerable distance, and exert considerable force, before the gun will be fired. It may seem as if the time were insignificant, but when it is considered how rapidly a ship rolls, and how swiftly a modern ship moves, and when it is remembered how small an error in elevation suffices to make a projectile fall short of, or go over, a ship which subtends a very small angle in a vertical plane, it will be seen that a fire which comes instantaneously with the coincidence of sights and target, is better than one which does not. Now, in firing by electricity, the gun captain holds a sort of push-button in his hand, which he simply presses when the sights bear on the target; and practical experiments abroad have shown that greater accu-

racy is attainable by this method than is attainable by the old methods.

But not only are modern vessels of war fitted with means for electrically firing individual guns, they are also fitted with means for firing any desired number together, the whole broadside even; for the effect upon an enemy of a blow from a whole broadside at once, is very much greater than the effect of the same number of guns fired at different times. The simplest way of doing this is to lead the electrical wires from all the guns to an armored fighting tower, where a cool officer, under the personal direction of the commander, with an electrical key-board and a good system of sights, can deliver the whole fire of the broadside at once upon an enemy. This officer, being clear of the smoke and away from the excitement and bustle of the battery, and with a view of the whole horizon, can clearly handle the battery with its maximum effectiveness; and, moreover, as soon as the guns have been laid at the range and in the direction at which it is intended to fire them, the men can lie down and be protected in a measure from the murderous fire of machine guns. Suppose that two modern ships are about to engage in a naval duel on the high seas, and that they are advancing towards each other at a speed of 14 knots an hour each, so that they are coming together at a rate of about 46 feet per second. The ships will, of course, begin to play on each other with their machine guns as soon as they get within range, so that as soon as the great guns are ready, the men had best be made to lie down on the deck, in rear of their guns. Now, the battery of each ship will probably be composed of guns firing projectiles of from 100 to 1,000 lbs., and each commander, knowing how much damage can be done by one well-delivered shot, knowing how long it takes to reload a modern gun, and appreciating the great speed at which the ships are approaching, will probably reserve his fire until sure that he has a good chance of making every shot tell. He will hardly fire at 2,000 yards range, knowing that his chance of hitting the rapidly moving target is small, and knowing that it will be only about one minute before the enemy will be at 1,000 yards range. Now, at 1,000 yards range, the machine guns of both ships will be working vigorously, and each ship will have an excellent target, but a target improving so rapidly that a commander would not wish to throw away all the shot of his great guns until a closer range is reached. One gun, for instance, might be fired now, having been previously laid for this range, of course; but probably it would be best to reserve nearly the whole broadside to be delivered simultaneously as the ships rush by each other at pretty close range. With the heavy guns and carriages of the present day it would be impracticable to keep a gun pointing at a ship under these circumstances, since both range and bearing are changing so rapidly. Therefore, the guns must be pointed in certain directions and laid for certain ranges, and fired when the enemy reaches the spots thus defined.

In the case of a fort, the value of firing by electricity is evident, since it can be employed in connection with the instruments used for determining at each instant the position of an approaching vessel or army. Different guns being laid at different ranges and in different directions, an officer in the operating rooms can keep track of the exact position of the enemy, and when the enemy reaches one of the predetermined points, all he has to do is to touch an electric key and fire the gun or guns controlled by that key, knowing that those guns are not only pointed in the proper direction, but also are elevated for the correct range. It would seem difficult to improve upon the accuracy obtainable by this method.

Whitehead torpedoes are now so arranged that they can be ejected by pressing an electric button; and the firing keyboard in the fighting tower of a ship indicates at any instant what guns and torpedoes are ready for firing. The fighting tower should also be fitted with engine and steering telegraphs, and indicators for showing whether the commander's orders to the engine and steering apparatus have been understood and executed, so that the commander can tell at a glance the exact state of affairs at battery, engine, and steering apparatus, and can have all the separate departments of his ship under absolute personal control.

(To be continued.)

PROPOSED TELEPHONE EXCHANGE AT BATH.

AT a meeting of the Surveying Committee of the Bath Town Council, held last week, Alderman GIBBS, who presided, referred to the proposal of the Western Counties and South Wales Telephone Company to establish an exchange at Bath. He thought that the company should be able to show that the trading community desired it, and also what the position of the Company would be towards the authority in the event of the scheme not proving successful. Would the company take down the wires?

Alderman BRIGHT said that he was not very sanguine as to the prospects of the proposed exchange, but, personally, he should not oppose it.

Mr. COX remarked that he presumed that the committee had only a right to interfere with the scheme when the wires crossed the streets, but of course Mr. Lewis, the secretary, would not like to ask tradesmen to subscribe before he had the permission of the authority to erect the wires. He pointed out that the secretary had promised that if an exchange were established in Bath, telephonic communication should be provided with all the public buildings free of cost. The company could not tell the exact route they wished to take, as they would only go where there were customers, but he did not think that the authority would go far wrong if they decided to sanction the scheme under certain conditions, for if there were not sufficient subscriptions the company would not come to Bath.

Mr. STURGESS said that he should not object to the principle, provided that the details were satisfactory.

Mr. COLLINS remarked that there would probably be some difficulty with regard to the owners of houses. It was questionable whether they would allow the wires to be erected.

The CLERK pointed out that they would make their own arrangements.

The CHAIRMAN said that in the case of proposed railways the promoters had to show the needs of the district they proposed to traverse before the consent of Parliament was obtained.

Mr. HEYWOOD said that it would be a very great advantage to the police and the fire brigades to have the wires. Many private houses, too, would wish to use the wires.

Mr. H. F. LEWIS, the secretary to the company, now entered the room, and, in reply to questions, said that no canvass of the city had yet been made, as they had not thought fit to do so until they got the consent of the corporation.

The CHAIRMAN said that Mr. Lewis would come to them with a much stronger case if he did that.

Mr. LEWIS replied that they had never done so before. They were quite prepared to take the risk. At Brighton and Bristol they opened with half-a-dozen subscribers, and in Brighton there were now 200 subscribers. They had put the subscription at £10, and he did not think they could promise any reduction if the number of subscribers became very large. They did not propose to erect any poles in the streets, and they could only do so with the consent of the authority. They proposed to cover a radius of one mile as the crow flies. They generally attached the general hospital and the head office of the police free of cost, and in Bristol he could say they had very few serious fires, as the engines were called by telephone within three minutes, and were generally at the fires in seven. He read extracts from a Parliamentary report, which stated that the danger arising from overhead wires was greatly exaggerated, and that the only fatal accident proved in evidence was due rather to a well-meant attempt to replace the wire, than to the fall of the wire.

Mr. WALKER expressed the opinion that the telephone was really established for the purpose of annihilating small tradesmen.

The CHAIRMAN thought that if sufficient grounds for the exchange were brought forward they should not place artificial restrictions in the way.

Mr. LEWIS said that the company would canvass Bath with pleasure. They did not expect the exchange to pay the first year; nothing less than 100 subscribers would pay them.

Mr. Lewis having retired,

Mr. COLLINS moved that the committee should favourably entertain the application if a sufficient number of subscribers were shown to be willing to take advantage of the scheme.

Mr. WALKER seconded.

Mr. STURGESS moved an amendment, to the effect that the committee, having heard the statements of Mr. Lewis, considered it right to accede to his request.

Mr. HEYWOOD seconded.

The amendment was carried by 8 to 5 votes.

Mr. LEWIS, having been informed of the decision of the committee, said he would take care to canvass the city before the next meeting of the council, at which the subject would be discussed, and then make known the result.

The Electric Organ in Animals.—Prof. Du Bois-Reymond, according to *Nature*, has recently availed himself of good opportunities for studying the electric ray in the live state; and among several important facts elicited by him is that of irreciprocity of conduction in the electric organ. That is, when short currents are passed through the organ in the same direction as that of the animal's proper current, viz., from belly to back, and in the reverse direction, the conductivity in the former case is considerably greater. This irreciprocity begins to appear only when the current has acquired a certain strength; it increases with the strength, but more slowly. Both this irreciprocity and the small conductivity of the organ (which is considerably less than that of sea water) are proved to be connected with the life of the animal; the former disappears and the latter increases in the case of spontaneous death. The former depends also on the duration of the current, diminishing with a continuous current. This phenomenon of irreciprocity appears to have the effect of strengthening the animal's current and so intensifying its physiological action in external space. The author's researches on the subject have been recently laid before the Berlin Academy (*Sitzungsberichte*, Berlin Academy, 1885, p. 691).

NOTES.

The Electric Light at Bournemouth.—The first installation of the electric light in this town was recently made at the Bourne Hall, the corridors and public rooms of which are now illuminated by electricity. The work has been successfully carried out by Messrs. W. J. Bacon & Co., of Regent's Terrace, Bournemouth, who were instructed and supplied with materials by Messrs. Paterson and Cooper. About 120 incandescent 60-volt Edison lamps are used, and the dynamo is driven by an eight horse-power engine, which was formerly used at the Junior Army and Navy Stores, Waterloo Place, London. The arrangements for lighting the dining hall are particularly worthy of notice, about 20 lamps being tastefully arranged in clusters of three pendants from the ceiling. The effect of the light in the main corridor, which reaches a length of 225 feet, is extremely pretty. The first trial of the electric light having proved so satisfactory, it is to be hoped that Bournemouth will now "keep the ball rolling."

The Electric Light in the Royal Navy.—A few months since an elaborate scheme for the lighting of the *Inflexible* was forwarded to the Admiralty for their Lordships' consideration. The plans have now been returned with an intimation that they are rejected on account of the unsatisfactory arrangements for the search lights and protectors. It is not suggested that there is any necessity for improvement in that portion of the scheme relating to the internal lighting. The *Bellerophon*, 20, ironclad, and the *Amphion*, 10, cruiser, have had a trial of their electric light machinery in the basin at Keyham, in the presence of Commander Conybeare, representing the Admiralty. The experiments proved thoroughly satisfactory. The officers of the *Vernon*, torpedo school ship at Portsmouth, have been directed to carry out a series of experiments in the Nordenfelt towers of the *Howe*, with the view of ascertaining whether the electric search lights could be placed there instead of in their present position.

Electric Lighting of Cook County Public Buildings.—The United States Electric Lighting Company some time ago secured the contract for lighting the Cook County Court house, and four other public buildings in Cook County, with a total of 3,700 incandescent lights, and the installations have now been completed. The court house employs a large power plant with four dynamos, sufficient to operate about 1,300 lights; the county hospital power plant, shafting, pulleys and dynamos for operating nearly 1,400 lights; the criminal court house and gaol a power plant and lamps for about 400 lights; the insane asylum a similar plant; and the infirmary, engines, boiler and dynamos for operating 250 lights. There were many difficulties to be encountered in the work, but these were successfully overcome.

Electric Lighting in South Africa.—In the course of a discussion which ensued upon the presentation of the electrician's report to the Town Council of Kimberly on the 11th ult., Mr. Councillor Cornwall suggested that some arrangement should be made with the Government for lighting the railway stations by means of electricity. The Council had the sole right for the use of the patent in that part of the world, and might make something out of it. The Mayor in reply, stated that acting upon his permission, the electrician had already communicated with the Government with reference to the matter.

The annual horticultural exhibition of the Griqualand West Agricultural and Horticultural Society, held on the 11th ult., in the Public Gardens, Kimberley, was effectively illuminated by means of two large arc lights, erected by Mr. K. L. Cousens, electrician to the Town Council.

The Ball Electric Lighting System.—The Ball Electric Light Company has just installed a 25-light plant (arc) in the extensive print works of S. H. Greene & Sons, River Point, R. I. So well satisfied are Messrs. Greene with the Ball system, and the economy with which it can be run, that they have determined to increase their plant to 100 lights.

Electric Lighting in Blackpool.—The Directors of the Blackpool Winter Gardens and Pavilion Company, Limited, have decided to illuminate their gardens, fernery, and floral halls, during the ensuing season, with the electric light, and have appointed a committee to make enquiries as to the best systems and report to the Board. These gardens are visited by over 600,000 persons annually from the busy hives of industry in the neighbouring counties of Lancashire and Yorkshire, and the buildings being so admirably adapted for the purpose, it is intended to make the installation an exhibition of all the latest developments and improvements in electric lighting.

Metropolitan Brush Electric Lighting Company's Shares.—An advertiser in a financial contemporary is offering 2s. per share for the shares of the Metropolitan Brush Company, which is in liquidation.

Telephonic Facilities at Bristol.—With the view of still further popularising the exchanges at Bristol and Clifton, the Western Counties and South Wales Telephone Company has circulated an important announcement to subscribers, in which it is intimated that those signing agreements for protracted periods will be conceded a considerable reduction in the terms. Private residences at Clifton or Redland, as well as the private residences and offices of present subscribers, can be connected with the Exchange on specially reduced terms. It is proposed to open, by way of experiment, call rooms in some half-a-dozen different parts of the city and Clifton, in addition to those at the Exchanges in High Street, Bristol, and at Clifton. The public will have access to these rooms at a nominal charge, and it is anticipated that this experiment will result in adding considerably to the roll of subscribers, which, it is satisfactory to learn, is daily getting larger. If a sufficient number of subscribers desire the accommodation, the directors propose to connect their exchanges with the chief telegraph office at Bristol, at an annual rental of £2 2s., so that subscribers may be able to transmit or receive telegrams at their own homes. The medical charities of the city are to be connected with the exchanges. These are all new privileges, but those which have been conceded for some time should not be forgotten, viz., continuous night and day service, connections with the principal cab-stands, the police, fire brigade, and ambulance stations. It is to be hoped that the company will be duly rewarded for the enterprise it has manifested.

Telephoning Election Results.—On the occasion of the declaration of the polls in the recent Parliamentary elections for Glasgow and suburbs, the services of the telephone system were largely called into requisition. From the County Buildings in Wilson Street, where the counting of the votes took place, the results were transmitted to the various newspaper offices in the city with the greatest despatch and facility, and were thus made public earlier than would have otherwise been possible. In the case of Greenock election the telephone was also utilised to convey the intelligence to Glasgow, and so favourable were the atmospheric and other circumstances that messages by the ordinary mode of telegraphing were anticipated by several minutes.

The result of the Dumbartonshire election was telephoned to Glasgow half-an-hour before the telegraphed announcement reached that city.

The Telephone at Keighley.—The Keighley Town Council has allowed the National Telephone Company to fix three poles in Lawkholme Lane, on payment of an acknowledgment, and subject to removal upon three months' notice.

The Telephone in Portsmouth Dockyard.—Experiments are shortly to be made with the view of extending the use of the telephone in Portsmouth Dockyard. It is proposed to make the electric shop the central exchange, and as a preliminary step, extend the wires, now connecting the North Corner with the gunnery ship *Excellent* and the *Vernon* torpedo school ship to the *Marlborough*, and through the electric shop, to the office of the Commander-in-Chief.

The Telephone at Windsor.—At a recent meeting of the Windsor Urban Sanitary Authority, Mr. Simpson attended, at the request of the Mayor, and asked for the co-operation of the authority in laying a telephone under the following circumstances :—He said he wished to have a telephone to connect his house with his farm, and he had applied to the Post Office to know the cost, and they gave him the cost of laying and maintaining at £33 5s. a year. That seemed to him a large sum of money, inasmuch as the Post Office had a telegraph wire laid the whole distance. He had since been in communication with the South of England Telephone Company, and they offered to do it for £18, either party to terminate the agreement by three months' notice. He had seen the mayor and the ex-mayor, Mr. Shipley, and Mr. Long, clerk to the board of guardians, and all these gentlemen expressed their belief that the plan was feasible, and that it would be advantageous, always supposing that it could be done at a reasonable sum. He then ascertained from the company that they would place the wire to Datchet and Old Windsor for £40 divided between four. His suggestion was, that the Sanitary Authority or the Board of Guardians might join in the arrangement. If they would pass a resolution authorising the Mayor to incur an outlay not exceeding £10 per annum there might be a probability of getting the matter in hand at once. Alderman Cantrell asked what use the telephone would be. The surveyor was in charge of the works. Messages were all very well, but personal interview and superintendence were far better. Mr. Harris said a representative of the South of England Telephone Company called upon him, but he was not prepared to pay £10 or £12 a year to have communication with the Ham. As to the advantage it might be to the authority, a telephone would lead to a good deal of saving of time ; but he should like the Health and Drainage Committee to consider the matter. Mr. Peters said there were many reasons why communication of this sort would be of advantage, and he moved that the matter be referred to the Health and Drainage Committee to report. Mr. Gane seconded. The Surveyor said it would be a very good thing ; but if they decided to have a telephone it would be better to put up one themselves, and not rent one from a company. The matter was then referred to the Health and Drainage Committee.

The Drawbaugh Telephone Case. — At Syracuse, N. Y., on November 28th, Judge Wallace, in the United States Court, heard the presentation of additional evidence in the case of the American Bell Telephone Company *v.* The People's Telephone Company *et al.* The case practically resolved itself into the question whether the electric speaking telephone was first invented by A. G. Bell or by Daniel Drawbaugh, of Milltown, Pa. By a recent opinion handed down by Judge Wallace, the Bell patents were allowed to stand, but the judge expressed some doubts on certain points, and this hearing is by a stipulation to reopen the case for the introduction of additional evidence on these points.

The Wicked Telephone Girl.—There had been an unusual electrical disturbance, and the telephone girl had received several discouraging shocks while answering calls. As might have been expected, this soured her temper more or less, and when 585 called, she uttered her customary "hello" so snappishly that the manager, who sat by, knew somebody was about to suffer. "Give me Mr. Bullwinkle's store, please," said Mrs. Bullwinkle, who had called. "All right! Is Mr. Bullwinkle there?" "No, ma'am," replied one of the clerks. "Do you know where he is?" At this instant the heartless girl switched on Warpman, who was describing the gentleness of a horse he was about to purchase to one of his friends, and the reply Mrs. Bullwinkle got was : "I was down to Farman's this afternoon, and when I went to the barn I found Farman's wife with her arms around his neck, and when I spoke about taking him away, she began crying, and said she would not be able to live without him." "She did, eh?" said Mrs. Bullwinkle into the transmitter. "The hussy!"—*American Paper.*

Telegraph Revenue.—The receipts on the telegraph service from April 1st to December 12th, 1885, amounted to £1,210,000 against £1,220,000 received from April 1st to December 13th, 1884.

The Chandler High Speed Engine.—This engine, which was described in the ELECTRICAL REVIEW of 24th December, 1884, has been such a success as to induce the maker, Mr. F. D. Bumsted, to build an addition to his works and put down special machinery at Hednesford purposely to afford facilities for their manufacture on a larger scale. They are in demand for ship purposes, being equally good for lighting, pumping and working fans. Last week we saw at these works 8-inch single engines which are being supplied to Messrs. Rankine and Blackmore of Greenock for a large Australian passenger vessel (the *Ozone*) to drive direct two Capell fans for forced draught. There were also others in hand for driving dynamos and fans on other vessels. All the engines of a given size are exactly alike and interchangeable, and a spare set of parts is applicable to any one. A "Chandler" 8-inch double cylinder engine of 20 horse-power is employed to drive the machinery in several of the shops at the Hednesford Works, a second 8-inch single cylinder serves another shop, whilst a 5-inch double cylinder drives a dynamo which lights up part of the works. We may also mention that several others were under test. The engine first mentioned, with 120 lbs. of steam, is capable of yielding 45 horse-power on the brake, and the space occupied is only about 6 feet × 2 feet. Those we saw running were so silent that it was at first sight difficult to tell that they were working, as nothing moving could be seen but a bright turned flywheel; we were told that steel and phosphor bronze constituted all the working parts, and the general "get up" of the engines appeared to be thoroughly genuine. One of the 8-inch single engines was required for the private steam yacht *Lady Beatrice* in a great hurry a few weeks since ; the engine was ordered and on board within a week, and the vessel set sail for India a few days later, the manufacturer being informed that it was running the incandescence lamps on board to the entire satisfaction of the owner. Several engines have been lately supplied from stock for pressing orders. A great improvement has recently been introduced with the view of keeping the lubricant in the crank chambers always at a uniform level, independent of any amount of rocking and tossing in heavy seas. This arrangement, which is both simple and ingenious, will form, we understand, the subject of a separate patent.

Economy of Fuel.—In our last issue we mentioned that in the trial of a 12 horse-power engine of Messrs. Ruston, Proctor and Co., the consumption of fuel amounted to but 2·63 lbs. of coal per effective horse-power per hour, equivalent to about 2·4 lbs. per *indicated* horse-power. We are now informed that Messrs. Hornsby and Sons' engines, which have been used during the concert season of 1885 for driving the Jablochkoff system at Covent Garden, consume only 2¼ lbs. of coal per *indicated* horse-power. These engines are respectively of 8 and 30 nominal horse-power, indicating together an average of 107·37 horse-power, and the result above-mentioned was obtained from 98 days' running for about 5 hours per day.

Elwell-Parker, Limited.—We were recently very much interested by an inspection of the works originally founded by Messrs. Elwell and Parker, and now extended and carried on by the limited company bearing their names. Such has been the development of the business during the few years it has been in existence, that the company have now resolved upon doubling its capital in order to provide for future extension. In the manufacture of dynamos and accumulators there are about two hundred hands employed. The process of dynamo-making commences at the foundry, in which the metals used are duly alloyed and cast with every care essential to securing excellence in these points. The various stages in making and winding follow on in capacious shops, furnished with machine tools of the best construction, most of the men employed being specially trained to their own individual share of the work, the advantage of division of labour being fully recognised and acted upon. Accumulator-making is conducted on the same principle, every detail of the construction being carried out upon the spot. We were glad to hear that the action brought against the firm by the Electrical Power Storage Company had been arranged, and in such a way that the public are likely to reap an advantage in the way of a better accumulator, combined, perhaps, with reduction in prices.

Stealing Electricity.—The leakage to the earth of the underground leads of the Edison electric lighting system, from the central lighting station in New York, U.S., is said by our New York exchanges to be about three ampères, the tension being 110 volts. Numerous unprincipled persons, it has been discovered, have availed themselves of the opportunity to steal electricity, and use it for operating motors, and for induction coils. The method of filching the electricity was by boring through the iron pipe surrounding the insulating compound, and then further into one of the copper leads; a set screw fixed into this orifice, formed one connection, and the earth the other. Of course this connection was made beyond the electric meter. It was hardly worth while to maintain the continuous espionage necessary to detect and punish these pilferers, but the superintendent of the station, Mr. Chamberlain (not Joseph), coupled in extra dynamos and threw as great an increase of current over the system as the safety catches would permit, at various times for about one second; while this current was passing the incandescence lamps would give an unwonted glow, and every induction coil and motor surreptitiously attached to the system would receive an extra current designed to burn it. In this manner the system is occasionally cleared of all trespassers.

Who's to Pay?—According to exchanges, neither the New York nor the Brooklyn Electrical Subway Commissioners have received one cent of their salaries. The law creating the Commission provided that the electrical companies of the respective cities should bear this expense, and as the said companies have not seen fit to send in their cheques the Commissioners have been compelled to bear all expenses from their personal accounts.

Another Accident.— The night foreman of the electric light works at St. Joseph, Mo., recently found Jas. W. Prashka, the engineer, lying beside the dynamo in an insensible condition. There was no one present at the time of the accident, but the supposition is that he attempted to take hold of the brushes on the dynamo with both hands, forming an electric circuit which prostrated him. The physicians say there is no possibility of his recovery.

Institution of Civil Engineers. — Mr. F. Geere Howard was announced to read a paper at a students' meeting of the Institution of Civil Engineers on Friday evening on "The Propulsion of Tramcars and Launches by Secondary Batteries."

Progress of Electric Lighting.—As an illustration of what is being done in electric lighting in a quiet way, we have recently heard that Mr. Wilson Hartnell, of Leeds, has put up no less than 1,877 incandescent lights in various installations in the present season. At Wentworth Castle the light has been introduced throughout the building to the extent of 400 lamps; at Radcliffe a paper mill has been furnished with 312 lamps; corn and woollen mills have been supplied with equipments of from 60 to 160 lamps each, and a number introduced into private houses brings the total to the figure given above.

Secondary Batteries in Hull.—The first attempt at storage of electrical energy in Hull has been most singularly successful, and has taken place at the offices of Messrs. Thomas Wilson, Sons, and Co. About a year ago these offices were lighted by electricity, the number of lamps spread over the extensive premises being 130. The dynamo machine was driven by a gas engine, but it was found that the explosions of gas which drove the engine rendered the light somewhat unsteady. Ultimately, to obviate this defect, it was decided to employ a set of accumulators, and the contract for this work was given to Messrs. Paterson and Cooper, who have put in a set of fifty-two of Joel's accumulators; these consist of plates made up of matted lead fibre, separated by cocoa-nut matting, and immersed in boxes filled with sulphuric acid and water. The combined cells are adequate to supply the whole 130 lamps for five hours.

International Inventions Exhibition.—The final list of awards made by the Juries, and confirmed by the Jury Commission, has now been issued. According to the official statement, since the issue of the first edition of the list, the Jury Commission has been engaged in considering applications from exhibitors who were dissatisfied with their award, and in cases where any error seemed to have been committed, or where the exhibit had been overlooked, the Jury Commission has endeavoured to repair omissions or correct mistakes; but the comparison of this list with that which appeared in the *London Gazette* of the 11th of August last, will show that the alterations have not been very numerous. The Jury Commission, now that its work is completed, has been dissolved. The design for the diploma, which has been drawn by Mr. Thomas Riley, has been approved by the Executive Council of the Exhibition, and is now in the printers' hands. It is expected that a diploma will be forwarded to each exhibitor who has received a medal within two months from the present time. The medals will be distributed as soon as they are ready, and this, it is believed, will be very shortly.

The New York Underground Wire Commission.—The citizens of New York are becoming impatient of what they regard as the dilatoriness of the Underground Wire Commission, and the Mayor, acting as their mouthpiece, has addressed a letter to the Corporation counsel, asking for his opinion as to whether or not the amendments to the Underground Telegraph Bill, passed by the last Legislature, extended the time for putting the wires underground, and also whether the city authorities had any right or power to move in the matter. The phrase "wherever practicable" in the amendment, and to which we have previously alluded, seems likely to cause some little difficulty; but, according to the view of the Corporation Counsel, "no express language has extended the time within which the requirements of the earlier Act are to be conformed to," and it is in his opinion very doubtful whether the provisions of the later Act, regulating the course of procedure to be followed by the Commissioners in selecting a general plan of underground subways, are so inconsistent with the earlier Act as to justify the conclusion that it was the intention of the Legislature to modify it in that regard. The Act of 1885, he thinks, relieves the city authorities of responsibility.

A Modification of the Bunsen Photometer.—A recent number of the New York *Electrical World* contains the following :—All who have occasion to use the Rudorf modification of the Bunsen photometer, in which the screen bisects the angle between two mirrors set with an angle of 140° between them for actual measurement, have no doubt met with the common difficulty of placing the screen exactly within certain limits. That is, after it has been set, it is possible to change its position considerably without altering to an appreciable extent the appearance of the spot. And again, where using, for instance, the constant-level Argand lamp to measure the intensity of the light of an arc lamp employing a screen with the ordinary grease-spot, the difference in colour of the two lights proves a source of annoyance and error. These defects are happily remedied in a modification of the Rudorf screen by an accomplished young officer, Lieutenant Millis, of the United States Corps of Engineers, and its perfect applicability is only equalled by its simplicity. The ordinary Bunsen screen, as is well known, consists of a ground of white paper doubled, in which, at the centre of the screen, is cut a circular hole which is closed by a single thickness of paraffined paper pressed between two layers of white paper. The modification consists simply in placing from one to four thicknesses of paraffined paper, according to the strength of the light to be tested, between the white sheets, and where these sheets appear at the opening the paraffined paper has a circular hole cut in it concentric with that of the white paper, its diameter being about one-third that of the latter. By this change the effect of colour seems to be eliminated, and in the reflected images, when the screen is at its proper position, we have an intense black centre in relief against a white ground. A slight movement of the screen along the bar alters this effect, and thus the utmost nicety of adjustment is rendered possible.

Smith, Baker and Co.—We have received a copy of the new and revised trade catalogue of Messrs. Smith, Baker and Co., of the Cornbrook Telegraph Works, Manchester, which, though dated September, is only just issued. It forms a book of 50 large quarto pages, and is beautifully printed in two colours by Messrs. Emmott and Co., of Manchester. It contains instructions for fixing electric bells, illustrated by numerous plans of connections, and figures of the various kinds of bells, indicators, pushes, and batteries, needed for various purposes. Telephone apparatus and lightning conductors are also fully described; dynamos, lamps, accumulators, wires, cables and fittings for electric lighting form another department; while a long list is given of galvanometers and other testing instruments, and a great variety of philosophical apparatus. The catalogue concludes with details and illustrations of the special machine tools for telegraph instrument makers, the manufacture of which now forms an important department of the business at Cornbrook. These tools were originally designed to meet the requirements of the work carried out by the firm, and successfully achieved the object in view, namely, to enable ordinary workmen to produce a class of work that had formerly necessitated the employment of highly paid and specially trained hands. It will be seen from this enumeration that the book is well worth the four stamps in return for which the firm is prepared to send it post free to any one in the trade.

Reckenzaun's Electrical Tramcars.—On Saturday last in Berlin Mr. Reckenzaun's system of tramcar propulsion was officially tried under the auspices of the Grosse Berliner Pferdebahn Gesellschaft, the Berlin Police Authorities, and other officials concerned in the administration of public safety and convenience, the inventor being also present. No private trials were allowed previous to this inspection, because the car could only be run in the public thoroughfares. Moreover, the worst portion of the line was selected for the trial; there being to start with curves of 33 feet radius, a long incline, and the rails blocked with snow and ice. The car was filled with the above mentioned officials, and started upon its journey amidst a great crowd, which soon collected. Not the slightest hitch, we understand, occurred during the whole of the trip, the car being stopped, started, and the speed varied at the command of the chief tramway inspector, the trial giving entire satisfaction to all present. The accumulators used in the car are charged from the central electric lighting station in the Ausstellungs Park, by a "Victoria" dynamo, at a distance of about a quarter of mile from the starting shed. The same machine is used at night for illuminating some of the buildings in the Park. We are glad to learn the result of Mr. Reckenzaun's visit, which he might well call, to quote the title of a "Strauss" waltz, "Mein Schönster Tag in Berlin," but should be still better pleased if he, or other inventors whose systems have been described in our columns, could, in this country, fairly start operations upon a working basis. That electrical propulsion will eventually be employed we firmly believe, and the only thing, therefore, is to emulate Micawber and patiently wait for something to turn up.

How is that for High?—At a recent meeting of the Southampton Town Council the town clerk stated that he had received a letter from a gentleman, in which he enunciated a scheme for the lighting of the whole of the town by means of one lamp placed on the top of the Bargate. (Loud laughter.) The letter was ordered to lie on the table.

Overhead Wires at Eastbourne.—At the last meeting of the Eastbourne Town Council, the Lighting and General Purposes Committee presented the following report :—"At a meeting of this committee, held November 26th, the committee considered the borough surveyor's report upon a letter of Mr. H. M. Sayers, applying, on behalf of the South of England Telephone Company, for permission to fix insulators and wires upon certain posts belonging to the corporation. Resolved : 'That this committee recommend that permission be not granted, as in their opinion overhead wires are dangerous.'" Dr. Ellis said he considered that it was a very great mistake not to give the telephone company every possible facility for carrying out its work. The result of the corporation refusing to grant the permission which was sought for would be that the company would have to fasten its wires to private points, which would mean that the stretches of wire would be much increased, and there would be greater danger from the breaking of wires. Underground wires were so expensive, and the difficulties of transmitting messages were so much increased, as to render that method practically prohibitive. A telephone exchange was of great public service, and in a town which boasted so much of its advancement, he was surprised that unnecessary obstacles should be thrown in the way of the company. He accordingly moved that the matter should be referred back to the committee. Mr. Skinner seconded the motion. Alderman Morrison said that if the company attached its wires to private points they could oppose it. Overhead wires were always most dangerous. Mr. Pearce said that a Telephone Exchange Company had been established in Terminus Road, and if they were not careful they would soon have a perfect network of wires over their heads. Ultimately the motion proposed by Dr. Ellis was lost by a large majority, and the decision arrived at by the committee was confirmed. When will the enlightened gentlemen who have to decide these local matters learn that the danger from overhead wires is practically nil?

Creditable Work.—We read that when Lord Tennyson's poem called "Vastness" appeared last month in *Macmillan's Magazine*, the London correspondent of a New York paper secured an early copy and cabled a great part of it, succeeding in getting it reproduced in his paper without a single error.

Mr. Charles Lever in America.—Respecting the articles on "Electric Lighting in the United States" which recently appeared in this journal, the Chicago correspondent of the *Electrical World* remarks :—"I have read with interest the observations of Mr. Chas. Lever on electric lighting in America. When in the United States Mr. Lever was a frequent caller at this office, and proved himself a diligent seeker of information concerning our system and methods, and a keen observer of the business as a whole. It should be remembered, however, that Mr. Lever is afflicted with a 'system,' and conclusions in regard to his observations should be tempered accordingly."

The Telephonic Litigation in America.—Upon the publication of the American exchanges now to hand, the decision of Secretary Lamar with regard to the applications for leave to bring suit in the name of the United States to cancel the 1876 patent of Alexander Graham Bell, was anxiously awaited, the hearing of the evidence on behalf of the various parties concerned having concluded some week or two previous. The *Electrician and Electrical Engineer*, dealing with the evidence adduced in support of the pleas of fraud, want of novelty and collusion, remarks : "It may, however, be said at once that no proof worthy of a moment's consideration was presented tending to support the charge of fraud in the Patent Office. As to the question of want of novelty, no evidence was presented other than that which has repeatedly been considered by the Circuit Courts, with the exception of the affidavits relating to the claims of Meucci, which have not, we believe, been judicially passed upon. The evidence tending to show collusion was of little importance, with the exception of the affidavit of Professor Gray, and even this stated, in substance, little more than his own personal opinion on the subject ; all the facts set forth by him in support of that opinion being already well known to those familiar with the course of litigation which has arisen under the Bell patent." The same journal also declares that, although among the counsel for the petitioners were gentlemen of acknowledged learning, eloquence and ability, they were placed at a manifest disadvantage by reason of their entire lack of familiarity with patent law and practice, and with the technical procedure of the Patent Office.

The Telephone in the Northern Counties.—The Northern District Telephone Company is progressing with its trunk lines between Hartlepool, Stockton, Middlesborough, and Darlington, and hopes to have all these important towns connected with the northern part of the county early in the coming year. It has engaged the services of Mr. G. F. Preston, who has had a good deal of varied and valuable experience in electrical affairs with the Globe and United Telephone Companies and the Anglo-American Brush Electric Light Corporation. With the view of affording its subscribers every convenience and advantage to be gained by the use of the telephone, the company has under consideration a plan for connecting the theatres in Newcastle with the Exchange, so that subscribers to the system can switch on a little pantomime or drama with the same ease that they can at present call a cab or summon the fire engine or police. It is hoped that the collieries, which are so numerous in Durham County, will afford a large field for the use of the telephone, as at present the arrangements for signalling in the various pits are of a very primitive description, and the company, with its usual enterprise, is offering to undertake this species of work at very reasonable rates.

The Tower Spherical Engine.—At a meeting of the Cleveland Institution of Engineers, held at Middlesborough, on Monday, Mr. Froude read a paper on "The Tower Spherical Engine," which was described in the REVIEW for February 16th, 1884.

Electric Lighting in the City.—The *City Press* understands that the Commissioners of Sewers have made arrangements with the Anglo-American Brush Electric Light Corporation to light the area bounded on the north by Fleet Street, Ludgate Hill, St. Paul's Churchyard, and Poultry, extending eastwards as far as the Royal Exchange, and bounded on the south by the whole length of Queen Victoria Street, and the Victoria Embankment, as far westwards as the City boundary.

A few days ago the electric lights which have so long illuminated St. Paul's Churchyard, Ludgate Hill and Circus and Blackfriars Bridge suddenly disappeared, and the reason for this is not quite apparent in view of the decision above stated. So that they are to be shortly renewed, however, with additions in other parts of the City, we must not complain, but wish, as we heartily do, the Corporation every success in its new undertaking.

The following are the heads of the proposition made by the Anglo-American Corporation, which is dated November 12th, 1885 : The company proposes to supply electric lighting to an area bounded on the north by Fleet Street, Ludgate Hill, St. Paul's Churchyard, Cheapside, Poultry, extending eastwards as far as the Royal Exchange, and bounded on the south by the whole length of Queen Victoria Street and the Victoria Embankment as far westwards as the City boundary. The company to substitute electric lights for the existing gas lights in the main thoroughfares, and to use electric arc lamps of 2,000 candle-power each, to be placed not more than 60 yards apart, unless otherwise required by the Commission. To maintain these lamps and keep them alight from sunset to sunrise at a cost of £26 each per annum. The existing arrangements for gas lighting are not to be disturbed, but to be left capable of being used if needed. Any expense incurred by the Commission in consequence of the failure of the electric light is to be refunded by the company. The contract with the Commission for public lighting to be in force for seven years, and the Commission to have the right to renew the contract on the same terms for a further period of seven years, and also to have power to terminate the arrangement on certain terms to be mutually agreed upon. The company to have the right (but not the exclusive right) to supply electricity to all houses and public or private buildings and premises within the district, and to have free wayleave for their necessary works. The company to have the free use of the lamp-posts and subways under the control of the Commission, and the Commission is to give them every facility for carrying out the work. The company will extend the arc lighting to any of the other streets required by the Commission, but the Commission may continue the use of gas in those streets if it prefers doing so. The Commission is not to be called upon to incur any cost in respect of the installation of the works of the company.

Lighthouse Illuminants.—Mr. J. R. Wigham has received a communication from the Trinity House in answer to a letter in which he recapitulated the points which he has before raised on the subject of illuminating material for lighthouses. The Elder Brethren, in reply, state that in all matters which have been the subject of complaint in connection with the recent experiments at the South Foreland they have afforded Mr. Wigham every explanation which can reasonably be expected beyond what is stated in the official report. That report, the Elder Brethren say, is before the public ; it has been made after careful consideration, and they are not disposed to depart from the general conclusions arrived at.

The Oppermann Failure.—The public examination of Carl Tunstall John Oppermann, electrical engineer, adjourned from November 15th, was continued before Mr. Registrar Hazlitt, on Thursday. Mr. Cooper-Willis again examined the bankrupt on behalf of the trustees, Messrs. H. Alabaster and C. H. W. Biggs, eliciting the information that since the last hearing he had received a letter from his brother, stating that the

Chicago house was indebted to the extent of $4,000, whilst there was due to the firm $2,000. The information supplied being insufficient, the examination was again adjourned until February 4th.

Inter-Colonial Submarine Telegraphy.—The *Financial News* states that the submarine extension westward of the already established telegraph service between Victoria (British Columbia) and Montreal is regarded in the Pacific province of Canada as only a question of time, and of no indefinite period either.

Mr. Swan's Miners' Lamp.—At a meeting of the North of England Institute of Mining and Mechanical Engineers, held at Newcastle last Saturday, Mr. J. W. Swan described his electric safety lamp for miners, which has already been described in these columns and which was exhibited at the meeting of the British Association at Aberdeen in September.

Electric Tramcars in Boston.—A company has been formed to run tramcars by electric motors between Lynn (Boston) and Nahant. The Boston and Lynn horse railroad company opposes the new company. It is thought that the Nahant people prefer the electric scheme.

The Murder of an Electrician.—Henry K. Goodwin was arraigned before the Supreme Court at Salem, November 6th, to plead to an indictment for murdering Albert H. Swan, at Lawrence, August 27th. Mr. Swan was a prominent operator in Bell telephone stock and territory, and at the time of his death was largely interested in the Molecular Telephone Company, General B. F. Butler and Colonel J. P. Sweeney appeared as counsel for defence. Goodwin answered to the indictment, "I did it, and always said I did." General Butler entered a plea of "Not guilty." The trial was fixed for December 28th.

Overhead Wires in Brooklyn.—The Brooklyn Subway Commission has consented to the issue of a joint permit to the fire department and the New York and New Jersey Telephone Company, to erect about 300 poles for telegraph and telephone wires in various parts of the city. The telephone company puts up the poles, giving the city a joint interest in them, and the right to string its wires upon them. The telephone company has also begun operations on Fulton Street, Brooklyn, for a new conduit, which when complete will run up Main Street to Fulton and thence to Flatbush Avenue, to Third Avenue, to Atlantic Street. The new system will not be in operation before January.

Long Distance Telephony in America.—The poles have been distributed through Bayonne city, New Jersey, for the line of the American Telephone and Telegraph Company, but an injunction has been served in the interest of Rufus Storey, a large property holder, which will hinder operations until some kind of settlement is reached. This line is intended for the introduction of long-distance telephony between the cities of New York and Philadelphia, and its progress will be watched with interest, says the New York *Electrician and Electrical Engineer*, as the business between these two points is of a character to make the enterprise a success if it can be attained anywhere in the country.

Photographing by a Flash of Lightning.—At the last meeting of the Franklin Institute Prof. Houston presented two photographs taken on a dark night by the light produced by flashes of lightning, in which a building and trees were distinctly shown. They were thrown on the screen by the aid of Prof. Holman's lantern microscope. The duration of the flash by which the plates were secured was estimated at the one three hundredth part of a second.

Determined to have the Electric Light.—The committee on streets, Lawrence, Mass., recently held a meeting to consider the petition of nearly 600 residents of South Lawrence to have the city government retain electric lights on the bridges and railroad crossings between Lawrence and South Lawrence. All present were unanimous for retaining the lights. After the hearing, the committee voted unanimously to recommend to the city government that the proposition of the Lawrence Electric Light Company to furnish lights for bridges, the Common and public streets, at the rate of $10 per month be accepted. About 20 electric lights are now in use.

Dangers of Underground Cables.—The people of Chicago have suddenly discovered that the danger of fire in houses is immensely increased by the running of electric cables underground near the houses and under the sidewalks. The matter is under the consideration of the City Council.

NEW COMPANY REGISTERED.

African Direct Telegraph Company, Limited.—Capital £300,000 in £10 shares. Objects: To construct lines of telegraph between the Island of St. Vincent and any other islands of the Cape de Verde Archipelago and between any of such islands and the West Coast of Africa, but without the written and sealed consent of the Brazilian Submarine Telegraph Company, the company may not construct or work any line of telegraph to Brazil. Signatories (with 50 shares each): *John Pender, 18, Arlington Street; *Sir James Anderson, 62, Queen's Gate; the *Hon. W. St. John F. Brodrick, M.P.; *Thos. Fuller, 13, Chesterfield Street; Lord Monck, 24, Onslow Gardens; W. R. Drake, 46, Parliament Street; *Marquis of Tweedale, Haddington, N.B. Directing qualification 50 shares; minimum remuneration £1,000 per annum, with an additional £500 in each year in which £5 per cent. dividend is paid. The signatories denoted by an asterisk are the first directors. Registered 14th inst., by Bircham & Co., 26, Austin Friars.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Ingrey Poore and Latham, Limited (Electric Engineers).—The registered offices of this company is at 51, Queen Victoria Street, E.C.

Pilsen-Joel and General Electric Light Company, Limited.—The annual return of this company, made up to the 30th ult., was filed on the 10th inst. The nominal capital is £84,400 divided into 28,000 shares of £3 each and 100 shares of £4 each, the whole of which are allotted. Upon the former, £2 5s. per share has been called, and the full amount upon the latter. The calls received upon the £3 shares amount to £59,116 5s., and upon the £4 shares to £400. The calls unpaid amount to £3,883 15s.

Coates-Macdonald Company, Limited.—An agreement dated 30th October and filed 3rd inst., cites that the Electric Apparatus Company, Limited, and Mr. E. W. Macdonald will each subscribe for 100 shares in this company, and the company has agreed to allot such shares credited as fully paid up. Mr. H. J. Coates is appointed managing director at a salary of £250 per annum, and Mr. Macdonald is appointed a director and secretary at a salary of £150 per annum. These appointments are for a period of ten years.

Telephone Company of Austria, Limited.—An agreement, dated 3rd inst. and filed on the 9th inst.,

provides for the allotment of 190 fully paid £5 shares as a bonus to certain subscribers to the 5 per cent. first mortgage debenture bonds of the company.

Bernstein Electric Lamp Company, Limited.—The statutory return of this company, made up to the 11th inst., was filed on the 14th inst. The nominal capital is £10,000 in £10 shares. 1,414 shares have been taken up and the full amount has been called and paid thereon. Registered office, 9, Commercial Road. Pimlico.

CITY NOTES, REPORTS, MEETINGS, &c.

Swan United Electric Light Company, Limited.

A GENERAL meeting of the shareholders of this company was held at the Cannon Street Hotel on Wednesday, under the presidency of Mr. J. Staat Forbes. The notice convening the meeting contained a note stating that it was intended to hold the meeting *pro forma* only, and, pending important negotiations as to the foreign business of the company, it would be adjourned until February 23rd next.

The Chairman said he was very sorry to call the shareholders to a *pro forma* meeting, but a meeting must be held once a year, and in December, and therefore there was no alternative. He was not in a position to lay before them any report, or to tell them very much, except that the directors would feel themselves in February in a position to present a report and accounts, and to deal with the position of the company when they knew it. The fact was, as the notice indicated, very important negotiations were now pending in Germany, where, he was sorry to say, they were also engaged in litigation, and he thought he could only indicate generally this, that it was very much to the interest of the company that they should adjourn the meeting to February. He, in common with Major Page, had spent some time in Germany trying to do there what they had done with, he thought, satisfactory results, in England, to see if they could not reconcile divergent interests, and instead of the Edison Company abroad and the Swan Company abroad cutting each other's throats, whether they could not, upon some terms or other, either have a treaty of peace or an actual fusion of interests. His own impression was, without predicting too much or being too sanguine, that now the common sense of the parties was directed upon the litigation, probably some advantageous results to both sides might come out of that litigation. Meanwhile they must not be alarmed if they heard that some formal law proceedings were going on in Germany. There was some satisfaction to him in the fact that while the law was as slow as in England, it was less costly, and he felt little concern as to those proceedings, because he believed they would succeed in putting an end to them by an agreement which should be very beneficial not only to the Swan, but also to the Edison Company. He hoped they reposed enough confidence in the directors to accept their reason for postponing any information, because it would certainly not be advantageous to the company to go into much detail. He therefore moved the adjournment of the meeting to February 23rd.

Mr. Cuthbert Quilter, M.P., a director, seconded, and the motion was carried unanimously.

Mr. Verity suggested that the directors might save the trifling expense entailed in securing proxies, as the shareholders were entirely with the board.

The Chairman replied that it was very kind to state that the board had so entirely the confidence of the shareholders, but "old birds were not caught by chaff," and until the company was in a position to pay a dividend they should continue to invite the proxies of those shareholders who did not think it worth while attending meetings, so that they might be prepared for emergencies which might occur.

The meeting then terminated.

Eastern Telegraph Company, Limited.—This company announces the payment, on January 14th next, of interest at the rate of 3s. per share on the preference shares of the company, less income tax, for the quarter ending December 31st, 1885; and that on the same day an interim dividend will be paid of 2s. 6d. per share in respect of profits for the quarter ended September 30th, 1885, with a bonus of 1s. per share for the half-year ending that date, on the ordinary shares of the company, both free of income tax.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—This company notifies that the coupon on its Five per Cent. Australian Government Subsidy Debentures, due on January 1st next, will be paid on and after that date at Messrs. Barclay, Bevan, & Co., 54, Lombard Street. Coupons must be left three clear days for examination.

Spanish National Submarine Telegraph Company, Limited.—The numbers are published of 59 six per cent. mortgage debentures, amounting to £5,900, drawn at the offices of the company, 106, Cannon Street, E.C., for re-payment at par on the 31st inst., at the National Bank of Scotland, Limited, 37, Nicholas Lane, Lombard Street, E.C.

Lancashire and Cheshire Telephonic Exchange Company, Limited.—The certificates for the new issue of 100,000 shares (1885) can now be exchanged for bankers' receipts.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 11th were £2,252, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended December 11th were £2,951.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this society was held on Thursday, December 10th, Mr. C. E. SPAGNOLETTI, President, in the chair.

The minutes of the last ordinary general meeting having been read and confirmed, and the list of new, and proposed new, members announced, the annual report of the council was read by the SECRETARY.

The report stated that during the year 7 members, 71 associates, and 22 students had joined the society, a total of 100. The losses by deaths had been 1 honorary member, 4 foreign members, 17 members, 12 associates, and 1 student, amongst these being Dr. Davy, who had so recently been elected an honorary member of the society. The Institution of Civil engineers had continued to grant the use of their lecture hall for the society's meetings. The papers read had been well divided between theory and practice, and had not been confined to any one branch of electrical science. The society's premium of £10 had been awarded to Dr. Oliver J. Lodge. The Paris Exhibition premium to Mr. W. H. Snell, and the Fahie premium to Captain H. R. Sankey, R.E. During the year a committee had been appointed to consider the question of electrical nomenclature, and the co-operation of all the universities, colleges and science schools had been secured. Resolutions had been passed with reference to the Electric Lighting Act, to the effect that electric lighting had not advanced as it ought to have done, in consequence of the restrictions which the clauses contained. The Board of Trade had been approached on the subject, and it was hoped that in the new Parliament the matter would be considered. Dr. Fleming's recent paper on the establishment of a National Standardising Laboratory had been approved by the council, and the suggestions made were being considered. The library of the society continued to be appreciated, the report of the librarian showing that the attendance during the year had been 461, of whom 167 were non-members. 260 volumes had been added, but it was pointed out that presents of sets of standard reference works would be very acceptable. The financial condition of the society was satisfactory, the further sum of £120 having been invested in the funds and £21 expended on additions to the library.

The usual votes of thanks having been past, a paper was read by Mr. W. J. MURPHY, on "A Method of Eliminating the Effects of Earth and Polarisation Currents in Fault Testing."

A paper was also read by Mr. H. KINGSFORD, on "A Method of Localising a Fault in a Cable by Tests from one end only," as follows:—

In experimenting some years ago to discover a trustworthy method of localising a partial fault in the case of a laid cable where no return wire was available, unsatisfactory results were nearly always obtained from the application of "Blavier's" tests pure and simple. I was then led to investigate, for the first time, a formula, which, until then, had never interested me; total severances of the cable, or faults, when both ends were available, having so far been the only defects which had occupied my attention. It needed, of course, but little consideration to trace the source of error, as testing to breaks had assured me of the well-known fact that the resistance of an end varies (as a rule considerably) in some ratio to the current through it, decreasing, with increased electromotive force, until a minimum resistance has been obtained. A partial earth would, of course, be affected in the same way by the so-called "polarisation." To obviate the error due to this fact, I devised a method which I shall presently state, and an account of which I have long intended to publish. It is most probable that I should have delayed longer, being anxious to publish at the same time other matter which I have not yet had time to work into shape; but I was reminded of my intention by reading a very interesting article by Messrs. J. Anderson and A. E. Kennelly in the *Electrician* of July 17th, 1885. These gentlemen recognise the source of error which I mention as accompanying the simple "Blavier," and suggest for its elimination a test the main principle of which is the same as that which characterises my own modification of that method. For reasons, however, which will, I think, be considered by most electricians

as sufficient, I can but think that my method may in some cases be preferable. That of Messrs. Anderson and Kennelly requires an observer, battery, and a set of instruments at each end of the cable—a mode of testing which would be apt at times, I consider, to involve some little anxiety at least on the part of the responsible person. My method requires tests from one end only, and is as follows:—In order that the current through the fault may be the same when the distant end is free as when it is to earth, proceed thus: First, by taking ordinary "Blavier," approximate to distance of fault, and let that approximation from testing station = x in ohms; from that we obtain approximate resistance from the fault to the distant end = y ohms —, and approximate resistance of fault = z ohms —. With these data we go to work to obtain an approximation to the resistance which must be inserted at the home end of the line when testing cable free at distant end. Should the test be taken on shore, there is perhaps no better method to adopt than that known as reproduced deflection. Using this method,

Let r = resistance of battery;

" r' = resistance of well-shunted galvanometer, or $\frac{g\,s}{g+s}$

" a = E.M.F. of battery.

Then $\frac{a}{r+r'+x+z} = \frac{a}{f}$ = current through fault when line is free at distant end;

and $\frac{a}{r+r'+x+\frac{y\,z}{y+z}} = \frac{a}{g}$ = current through x when line is to earth at distant end.

Portion of $\frac{a}{g}$ flowing through fault = roughly $\frac{\frac{a\,y}{g}}{y+z}$

Let this quantity = $\frac{a}{h}$, then $h - f$ will represent the first approximation for resistance to insert, in ohms, or R_1. Then, placing R_1 in circuit, we now take another observation with the line free at distant end, and then test again from the actual end of cable, with the distant end to earth. Thus, in the same manner as we procured x, y, z and R_1, we obtain x_1, y_1, z_1 and R_2, and so on until we find that $R_n = R_{n-1}$. Results obtained with this insertion will be correct if the test be carefully taken. On board ship I prefer to use a Wheatstone bridge, and shall consider a case in which an even bridge is employed. Should it be deemed advisable to use a dividing bridge, the necessary slight alteration in formula will, of course, suggest itself. We first take simple "Blavier" as before, and obtain from the same, approximations x, y and z.

Let a = E.M.F. of battery;
" r = resistance of battery;
" r'' = " in either side of bridge;
" R, R_a, R_b, &c. = resistance unplugged when equilibrium is obtained with distant end free;
" R', R'^a, R'^b, &c., = resistance unplugged when equilibrium is obtained with distant end to earth;
" R_1, R_2, R_3, &c. = first, second, third, &c., approximations in ohms to resistance which must be inserted when testing line free at distant end, R_n being correct insertion.

Then, when distant end is free,

$$\frac{a}{r+\frac{r''+R}{2}} = \frac{a}{c} = \text{current through fault;}$$

and when distant end is to earth,

$$\frac{a}{r+\frac{r''+R'}{2}} = \frac{a}{d} = \text{current through "}x\text{."}$$

In the same manner as before we now find quantity of $\frac{a}{d}$ flowing through fault. Let this quantity = $\frac{a}{e}$, then R_1 will equal 2 $(e - c)$. Having now obtained R_1, we proceed as before to obtain x', y', z', always testing, of course, from the actual end of cable when distant end is to earth. We must proceed until insertion represented by R_n = that represented by R_{n-1}. I may hint with possible advantage to some readers that it is an excellent plan to make up a Wheatstone bridge of cable when practicable, especially in cases when the resistance to the fault is small, and when the fault is of such a nature as to require the application of a powerful electromotive force. In cases where the fault is considerably nearer to one end, tests should be taken from that end if possible. In the case of a high resistance fault near the distant end of the line R_1, R_2, &c., might at times be so high as to seriously interfere with the sensitiveness of the test; in such cases the E.M.F. must be altered. Should we find that additional inserted resistance makes no difference in result, we shall be safe, of course, in accepting such result as correct. As in every instance in which I have employed this method it has given me great satisfaction, I now publish it in the hope that others may find it as useful to them as it has proved to me.

In the discussion which followed the reading of the papers,

Prof. AYRTON pointed out that the method suggested by Mr. Murphy would not effect the required object.

The discussion was continued by Messrs. PERRY, ADAMS, PREECE, DONOVAN, FORBES, MORDEY, A. SIEMENS and Captain CARDEW.

The announcement of the ballot for the new council was then made as follows:—

President—Prof. D. E. Hughes, F.R.S. *Vice-Presidents*—Sir Charles Bright, M. Inst. C.E.; Edward Graves; Colonel Sir Francis Bolton; J. Hopkinson, M.A., D.Sc., F.R.S. *Ordinary Members of Council*—William T. Ansell, F.R.G.S.; Prof. W. E. Ayrton, F.R.S.; E. B. Bright, M. Inst. C.E.; R. E. Crompton, M. Inst. C.E.; William Crookes, F.R.S.; Prof. George Forbes, M.A., F.R.S.E.; Alexander Siemens; Augustus Stroh; Captain Phillip Cardew, R.E.; J. A. Fleming, M.A., D.Sc.; Prof. John Perry, F.R.S.; Prof. Silvanus P. Thompson, B.A., D.Sc., F.R.A.S. *Associate Members of Council*—W. Lant Carpenter, B.A., B.Sc.; Gisbert Kapp; John Munro. *Honorary Treasurer*—Edward Graves. *Honorary Secretary*—Colonel Sir Francis Bolton. *Auditors*—J. Wagstaff Blundell; Frederick C. Danvers. *Honorary Solicitors*—Messrs. Wilson, Bristows and Carpmael.

After the usual votes of thanks the meeting adjourned till January 28th, 1886.

Physical Society, November 28th, 1885.

Prof. F. GUTHRIE, President, in the Chair.

Mr. T. H. Blakesley was elected a member of the society.

The following communications were read:—"On the calibration of galvanometers by a constant current," by Mr. T. MATHER. A current is passed through the coils of a galvanometer, which may be of any form; the galvanometer is turned in a horizontal plane through any angle, which need not be recorded, and the deflection, θ, of the needle noted. The current is then broken and the needle swings back, taking up its position in the magnetic meridian; the angle through which it turns to do this is also noted, d. This is repeated with the galvanometer in various positions, and with the same current, and a curve is drawn showing the relation between the values of $\frac{\sin.\,\theta}{\sin.\,d}$ and corresponding values of θ. When the instrument is now used in its normal position, it is readily seen that a current producing a deflection, θ, of the needle is proportional to the value of $\frac{\sin.\,\theta}{\sin.\,d}$ corresponding to θ obtained in the calibration experiment, which may be read off at once from the curve.

"On a machine for the solution of cubic equations." By Mr. H. H. CUNYNGHAM. This machine the author believes to be the only one hitherto constructed that gives the imaginary as well as the real roots of a cubic equation. A cubical parabola is drawn upon paper; the ordinates being the cube roots of the corresponding abscissæ. To find the roots of a cubic, first reduce it by Cardan's rule to the form $x^3 - A\,x - B = o$. Then measure off along $o\,x$ a distance equal to B, and from this point, T, draw a line making an angle equal to $\cot.^{-1} A$ with $o\,x$. The ordinates of the points where this line cuts the curve are the roots of the equation. To find the imaginary roots when they exist, first find the real root as before; from this point draw a tangent to the branch of the curve the other side of $o\,y$, then if this line cut the axis of x at a point, Q, and a be the real root, the two imaginary roots are:

$$\frac{a}{2} \pm 2\sqrt{\frac{Q\,T}{a}}$$

Instead of actually going through the construction as above, the operation is preferably performed by applying a protractor with a tangent scale to the curve with its centre at T, setting off and reading off the point of the curve cut by its edge.

"On a machine for the solution of equations," by Mr. C. V. BOYS. After mentioning Mr. Hinton's apparatus lately shown to the society, and briefly describing Mr. A. B. Kempe's equation machine, Mr. Boys explained a machine he had constructed consisting of a system of beams, each provided with a pair of pans, and working upon a fulcrum at the middle. The pans of the first beam are marked $+ a$ and $- a$, those of the second $- b$ and $+ b$, the next $+ c$ and $- c$, and so on. Into these, weights equal in value to the coefficients a, b, c, &c., of an equation $a + b\,x + c\,x^2 + \ldots = 0$ are to be placed. A sliding joint is arranged to connect a point opposite the positive pan of each beam, with a rib at the back of the next lower one. Alternate beams are placed opposite one another, and each set can be slid past the other, the peculiar connecting joints being able to slide past the fulcra and the pans on each beam. To solve an equation, the coefficient weights are placed in their pans and the two sets of beams are made to slide past one another. At certain positions the beams change the direction of inclination. These positions of balance are noted on a scale, the readings of which are roots of the equation. When there are not more than two impossible roots, the machine will find them; for this purpose the real roots are first found and divided out, the resulting quadrant being placed on the machine. Instead of a change of inclination of the beam, a maximum or minimum of pressure is observed by a spring balance. The reading of the scale is then the real part of the root, and the square root of the pressure the impossible part.

Mr. A. HILGER exhibited and described a new driving clock work of isochronous motion, regulated by a fan governor, and a new direct vision spectroscope.

NEW PATENTS—1885.

15050. "Portable electric thief detector." A. COKE. Dated December 8.

15105. "Cells for generating electricity." J. A. KENDALL. Dated December 9.

15119. "Telegraphic apparatus." E. J. HARLING, S. J. GRIFFIN. Dated December 9.

15141. "Electrical converters." S. Z. DE FERRANTI. Dated Decembor 9.

15147. "Electric telephony." J. G. LORRAIN. Dated December 10.

15231. "Insulating medium for protecting iron and steel ships from corrosive or electro-galvanic action set up between the iron or steel plates and materials used in anti-fouling compositions." J. BLENKINSOP. Dated December 11.

15251. "Distributing electric energy." S. Z. DE FERRANTI. Dated December 11.

15266. "Illustrating the principal magnetic forces affecting and disturbing the mariner's compass on board an iron ship, and mode of compensating the deviation of the compass." G. BEALL. Dated December 12.

15268. "Appliances for regulating the electromotive force of the current or electric currents." C. J. BOSANQUET, W. CAMERON, W. R. TOMLINSON. Dated December 12.

15277. "Electric locomotives." R. H. HUTCHINSON. Dated December 12.

15285. "Manganese voltaic batteries." B. PELL. Dated December 12.

15324. "Telegraphing, and telegraphing apparatus used in connection with engines." W. CHADBURN. Dated December 14.

15325. "Connecting threads of carbon with platinum wire." C. SEEL. Dated December 14.

15344. "Electric registers and recorders for fares, &c." E. A. SCALES. Dated December 14. (*Complete.*)

15352. "Microphones." R. WREDEN. Dated December 14.

15363. "Electric battery cell." W. BALCH. Dated December 15.

15422. "Completing and breaking electric circuits." O. E. WOODHOUSE, F. L. RAWSON, W. WHITE. Dated December 15.

15424. "Measuring electric resistances." O. E. WOODHOUSE, F. L. RAWSON, J. H. DAVIES, E. J. MOYNIHAN. Dated December 15.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

13880. "Improvements in self contained or portable electric apparatus for electric lighting or otherwise utilising currents of electricity." J. S. WILLIAMS. Dated October 20. 11d. In the portable apparatus the magazine of electricity or secondary batteries or accumulators are arranged within or combined with a stand, casing or holder, and in combination with such arrangements, the inventor employs an electric circuit from the battery or accumulator and means in combination with such circuit adapted to operate either automatically or manually for regulating the electric force or energy passing from such accumulator or secondary battery through the circuit to the lamp or other working resistance or resistances employed for the utilisation or transformation of such force.

13883. "Improvements in the manufacture of the filaments or light emitting portions of electric lamps." J. S. WILLIAMS. Dated October 20. 6d. Relates to the construction of incandescent lighting apparatus in which an indestructible base or support for the conducting material is employed, such material being reduced to a minimum in any given cross section from which light is emitted or to be emitted upon the passage of an electric current.

15547. "Improvements in telephone switches." T. BALLARD. Dated November 26. 6d. In the improved invention the receiver is hung on a rigid bracket or projection, but in order to place it there a lever in connection with the switch has to be raised, and remains in that position as long as the receiver is hung up. When the receiver is removed the lever is brought back by means of a spring or other equivalent mechanism thus regaining its first position and actuating the switch.

15574. "Electric lighting of trains and other vehicles." W. A. DUNCAN. Dated November 26. 6d. The inventor proposes to place in conjunction with a revolving wheel or axle, a brush of metal connected with a dynamo machine then generating the electricity by the revolutions of the said axle or wheel.

15908. "Improvements in the application of magnetic force to the closing of doors, boxes, hand bags, and similar useful purposes." R. S. MOSS. Dated December 3. 8d. The inventor inserts a magnet in the door jamb, in a convenient position, and in like manner, fits into the corresponding part of the door a bar of steel. When the door is closed the magnet and steel are in contact, or nearly so, and the door is thereby held in such position until opened by hand.

16805. "Improvements in the production of a carbonisable material suitable for the manufacture of carbons for electric lamps, and in the manufacture of this material for this and other purposes to which it is applicable." F. WYNNE and L. S. POWELL. Dated December 22. 6d. Consists in the use of solutions of zinc chloride, zinc iodide, zinc bromide, chloride of bismuth, iodide of bismuth, bromide of bismuth and others, and certain mixtures of the above with each other to dissolve cellulose in the form of cotton or other vegetable fibre; and consists in the manufacture of such solutions and in the obtaining of it, pure and free, from oxychlorides, and in the employment of such solutions, or each or any of them, for the production of a transparent horny substance, which is also a carbonisable material, and suitable for the manufacture of carbons for electric lamps and other purposes, such as insulating wires, imitation parchment, artificial ivory, &c.

16916. "An improvement in multipolar electric machines." J. D. F. ANDREWS. Dated December 24. 6d. Relates to multipolar dynamo-electric or electro-dynamic machines which have for their armatures coiled rings of the Pacinotti or Gramme kind, and consists chiefly in so connecting the coils to each other and to the plates of the commutator that an even number of polar fields, such as 4, 6, 8, &c., may be arranged around the ring to operate effectively on the coils, producing greater power and uniformity of action than when only two polar fields are employed.

1885.

1221. "Improvements in secondary batteries." W. H. AKESTER, R. MITCHELL, and R. R. KELLY. Dated January 28. 4d. The inventors take a sheet, and a separate narrow strip of thin rolled lead, and a sheet of the asbestos paper or cloth or other suitable material of about the size of the sheet of lead; and about the opposite side edges of the asbestos sheet they bend or fold the sheet and strip of lead, bending or folding the strip of lead about the one side edge of the asbestos sheet, one half its width on each side thereof, and bending or folding the sheet of lead about the other and opposite side edge of the asbestos sheet, on the one side for about the same width as the half width of the narrow strip, and on the other side of the asbestos sheet for the whole of its remaining width, excepting a narrow insulating space which is left between its edge and the adjacent edge of the narrow strip on the same side of the asbestos sheet, so that each asbestos sheet is covered with a lead plate on its one side, excepting the said space adjacent to its one side edge, and on its other side is exposed excepting at its opposite edges where it is covered by the half width of the lead strip and by the like width of the lead sheet.

1505. "Improvements in and relating to electric batteries." W. R. LAKE. (Communicated from abroad by H. L. Brevoort and I. L. Roberts, both of Brooklyn, New York.) Dated February 3. 6d. Consists partly in the employment in a battery of per-manganate of potash and bi-chromate of potash. It also partly consists in the combination in a battery of per-manganate of potash and bi-chromate of potash as depolarisers with a non-acid solution. It also partly consists in the combination in a battery having zinc and carbon elements of bi-chromate of potash and per-manganate of potash as depolarisers. It also partly consists in the combination in a battery having an exciting solution consisting of the chloride of an alkali dissolved in water of bi-chromate of potash and per-manganate of potash. It also partly consists in the combination with a battery element of a conductor to be secured thereto by means of a conductive metal or metallic alloy applied in a molten state, and being of such character that it will expand in cooling so as to secure the carbon element and conductor together.

2555. "Improvements in apparatus for transmitting and receiving electrical signals." J. C. MEWBURN. (Communicated from abroad by Marcel Deprez and B. Abdank-Abakanowicz, both of Paris.) Dated February 25. 6d. Consists in means of producing a current by one or more coils or bobbins which have a to and fro motion imparted to them in a magnetic field by means of a spring or springs or their equivalent made to vibrate by being moved by the application of manual power out of the normal or central position and then released or let go. The spring carries the coil (or it may carry the magnet instead of the coil) and transforms the power applied into electricity by imparting the said to and fro or vibrating motion to the coil (or to the magnet). The invention comprises apparatus constructed on the same principle for receiving electrical signals from a distance, that is to say the coil or bobbin (or the magnet) of the receiving instrument is carried by a spring and similarly vibrates across the magnetic field when the spring is acted upon.

3850. "Improvements in shunts or contact variers, or automatic cut-outs or short circuiters for magneto call or signalling bells or for other purposes." G. A. MASON. Dated March 25. 6d. The inventor actuates the armature of the magneto-electric generator by means of a shaft and a crank handle in the ordinary way but he connects the crank handle to the shaft so that it has a movement of rotation imparted to it independently of the shaft until a spring is removed from the short circuiting contact which it made when the parts were in their normal position and so that

when the crank is operated it throws the armature into the circuit and maintains it in circuit whilst the crank is rotated, but as soon as the crank handle is released the said spring or contact piece automatically returns to its original position to short circuit or cut out the coils of the magneto armature.

5349. "Improvements in the manufacture of tanks and cells for electrical and other purposes." D. A. DAVIS. Dated April 30. 4d. Consists in the application of cellulose compounds or products such as parkesine, &c., to the manufacture of tanks and cells for electrical and other purposes, whereby such vessels are rendered both water and acid proof.

5801. "Improvements in electric bell pushes, contact makers, and indicators." C. BROTHERHOOD. Dated May 12. 6d. Consist in combining with electro or other magnets inserted in the circuit an armature free to vibrate under the influence of such magnets on contact being made and an intermittent, undulatory, or constant current being set up in the circuit, the said armature being so arranged and fixed to any part of the apparatus, as to set up a vibration, or series of vibrations which shall be communicated as a sense of such on the finger of the operator or on his sense of touch, something after the manner indicated in previous patents secured by himself and one W. A. Leipner.

5854. "Improvements in apparatus for 'heliographic' signalling by electricity." E. S. BRUCE. Dated May 12. 6d. Consists in the combination with a captive balloon constructed of translucent or semi-translucent material inflated with hydrogen gas in the usual way, of one or more incandescent electric lamps placed within the balloon, a metallic circuit forming or combined with the rope by which the balloon is held captive, a battery, and a suitable circuit closer for producing flashes of light in accordance with any prearranged code of signalling.

8813. "Improvements in telegraphic apparatus." P. B. DELANY. Dated July 21. 6d. Relates to improvements in the system of telegraphy for which a patent was granted to Sydney Pitt, a communication from the author dated October 9th, 1883, No. 4787. That patent relates to a system based upon the synchronous movement of apparatus at two connected stations. With an ordinary relay the interruptions in the circuit in the synchronous system would probably cause a singing or chattering of the relay and sounder. The inventor in the present invention employs a condenser as a shunt to the relay.

8827. "Utilisation of electric clocks for advertising purposes." J. ALLEN and F. LORRIMAR. Dated July 22. 2d. The inventors purpose exhibiting electric clocks in wooden cases with glass fronts, showing the whole of the interior arrangements of the said clocks (the said arrangements consisting of wires, works, battery, and skeleton dial) to public view, the advertisements being displayed around the clocks.

9817. "Improvements in incandescence electric lamps." F. WYNNE. Dated August 19. 4d. Consists in producing a form of "incandescence" lamp with lengthened stem, and mechanical inside support to the metal wires; this lengthened stem obviates the necessity of placing a waterproof covering over the connections, these being placed beyond the reach of the water or other destructive agent, and at the same time offers a lamp which is not more liable than an ordinary lamp to be broken by exposure to shocks.

9569. "Improvements in apparatus for controlling signalling apparatus and points of railways by electricity." E. J. HOUGHTON. Dated August 11. 4d. Has for its object to prevent a train engine or vehicle from entering a block section of a railway until a preceding engine or train has passed out of it, by locking the starting or other signal by a current of electricity controlled by the train or engine travelling on the section.

9795. "Improvements in telegraphy and telephony." F. H. BROWN. Dated August 18. 6d. Has for its object the transmission of telegraphic or telephonic messages between distant points by means of induced currents produced by the use of permanent magnets, and without the use of a battery current.

10181. "Improvements in galvanic batteries." SYDNEY PITT. (Communicated from abroad by S. Stepanoff, of St. Petersburg.) Dated August 27. 4d. The inventor takes a plate of zinc and encloses it in parchment paper, in the manner indicated by M. Reynier, but taking care to wrap around the plate a few turns of twine of two or three millimetres in thickness, so that the paper may not adhere to the plate, and that the gas may be developed and escape freely. Above the wrapper of parchment paper are also applied a few turns of twine, arranging them at right angles to the turns of twine upon the zinc plate. Then upon the two faces of the wrapper of parchment paper are applied two plates of copper, held in place by means of copper bands soldered to the edges of the copper plates. Each of the zinc and copper plates is furnished with a metallic band, serving as an electrode and to connect the elements the one to the other. The element thus prepared is placed in a mixed solution of sulphate of zinc and sulphate of copper, taking the two salts in about equal quantities.

10373. "Improvements in and relating to electric lighting apparatus." W. R. LAKE. (Communicated from abroad by H. P. Brown, of Chicago.) Dated September 1. 8d. Consists in arranging all the lamps in automatically adjustable, shifting or changing groups, as contradistinguished from prearranged groups, so that whatever number of lamps may happen to be in use at any one time, they will always be automatically divided into such number of groups as their number will form, the groups themselves being arranged in series, and the fraction of a group, if any, being left over at the end near the return terminal of the main wire circuit.

10496. "An improved air pump, chiefly designed for use in the manufacture of electric lamps." W. R. LAKE. (Communicated from abroad by P. Wrady, of St. Petersburg.) Dated September 4. 6d. This invention relates to a pump chiefly designed for exhausting the air from the glass bulbs of electrical incandescence lamps, but also applicable for other purposes. The improved pump enables the air pressure in the said bulbs to be reduced to $\frac{1}{7000000}$ of the atmospheric pressure, and even below this point.

10600. "Improvements in telephone repeaters." C. A. ALLISON. (Communicated from abroad by M. G. Farmer, of America.) Dated September 8. 6d. Consists of an electro-magnet having a polarised vibrating armature, and connected with one circuit in combination with pivoted strips or blades held in contact with a projection from the armature, and connected with a second circuit.

10606. "Improvements in curative voltaic batteries." R. M. KENNEDY. Dated September 8. 4d. Relates to an improved construction of those voltaic piles or batteries which are adapted to be worn or suspended upon the person for remedial purposes.

10950. "Improvements in telephonic apparatus." O. IMRAY. (Communicated from abroad by W. Burnley, of America.) Dated September 15. 1s. Has for its object principally to provide an improved telephonic transmitter, and to such end the first part of the invention consists essentially in the introduction of a condenser into a telephonic circuit at any point between a telephone transmitter and the line wires. The second part of the invention consists of a multiple transmitter with a series of diaphragms.

CORRESPONDENCE.

"Primary" and "Secondary" Batteries.

The term "reversible" which M. Hospitalier proposes to use in connection with batteries will doubtless meet with favour in many quarters; but, inasmuch as it is a new term, it does not help us to distinguish between a primary and a secondary battery, unless we accept the proposition that all batteries which are (according to M. Hospitalier's definition) "reversible" are also "secondary."

M. Hospitalier, however, appears to guard against this proposition when he says: "*Primary* or *secondary* batteries of lead are naturally *reversible* batteries." He goes on, however, to say: "All batteries, in which the regeneration of *every part* could not be effected electrolytically, would be a *non-reversible* battery."

Now, if every part can be regenerated electrolytically, the battery falls within Mr. FitzGerald's definition of a *secondary*. What, then, is a *primary* battery, which is also reversible?

It would appear that M. Hospitalier considers a battery to be *primary* or *secondary* according to the method of employing it; and he even claims that this results from Mr. FitzGerald's definition. Mr. FitzGerald, in your last issue, disclaims this interpretation of his definition; and, indeed, it is difficult to see how such a construction can be put upon his definition. It is also difficult to see how, according to M. Hospitalier's own definition, a battery can be classed according to the way in which it is employed, and not according to its capabilities.

Mr. FitzGerald says: "A secondary battery is one in which the elements *may be* restored . . . &c." M. Hospitalier says: "We call a reversible battery every battery *capable* of being regenerated electrolytically."

One would say that from both these definitions it follows that a battery should be classed, not according to the method in which it is intended to employ it, but according to what it is scientifically possible to do with it. If it is scientifically possible to recharge it electrolytically, then it is a secondary; and then, also, it is reversible. The converse also holds good; therefore a battery which is reversible is also secondary, and *vice versa*.

The fact appears to be that both Mr. FitzGerald and M. Hospitalier have implied, in the first instance, a distinction between a *battery* and the *elements* of a battery, which distinction, however, is not logically adhered to throughout.

The term *battery* must be taken to include both the elements and the electrolyte, and therefore Mr. Fitz-Gerald's definition would read better:—A secondary battery is one which, after being discharged, *may be* restored to its original active condition . . . &c.

M. Hospitalier evidently has in mind only the regeneration of the elements when he says: "Primary and secondary batteries of lead are naturally reversible batteries, as the regeneration takes place in the bath where the discharge is effected, or in a special bath." There would be no incongruity in this if he had used the word *elements* instead of *batteries*; for further on he specially guards against the supposition that a battery is reversible unless the electrolyte as well as the elements may be regenerated electrolytically.

We may take it, therefore, that the terms "secondary" and "reversible" are synonymous; and that these terms apply to any battery which it is scientifically possible to recharge electrolytically, access being had only to the terminals of the battery.

We may say, further, that the *elements* of a battery are "secondary" or "reversible," if it is scientifically possible to re-energise them electrolytically, without the aid of any other process.

W. Kingsland.

Re Electrical Formulæ.

Mr. Moon's further remarks contain hardly anything but mistakes, some of which are too grave for me to ignore.

Mr. Moon says I do not in my last letter refer to magnetos, but I do; with F I refer to magneto-dynamos, with $F \times \frac{w\,a}{w\,a + w\,m}$ to electro-magnet dynamos. Further, that I assert that the electrical efficiency is proportional to F. This is not the case; I pointed out that the proportionate waste $\left(\frac{\kappa\,a}{F\,V} \ldots \text{IV.}\right)$ is inversely proportional to F. If Mr. Moon takes the efficiency as the reciprocal of the waste, that must be on his own responsibility; wherever I use the expression efficiency I understand: 1 − proportionate waste. Mr. Moon says: "The equation for the annual expense of converting a given amount of energy is obvious enough; but Mr. Andersen's explanation of it in the following column is by no means clear. If he means . . . . the electrical output of work will vary directly as F, this is not exactly the case." Now, why should I mean this, when I say, as cited by Mr. Moon himself, "a given amount of energy converted," which is the correct form, and which gives the exact proportionality?

Mr. Moon is constantly bringing in confusion in trying to identify the coefficient with some formula for efficiency. I have shown that the annual expenses on dynamos in work, so far as they depend on the electro-magnetic construction, are theoretically as the reciprocals of the coefficients of the different types of machines. It is this property which, to my mind, gives the coefficient importance, since neither of the usual formulæ for efficiency gives a similar estimate of the value of a certain dynamo construction. But, according to the remark with which Mr. Moon concludes his letter, it would seem that he finds the deadly weapon against the coefficient in this very circumstance. Need I say that his hope of having convinced me of the uselessness of the coefficient is vain?

"The duties required of dynamos differ so much in their nature, and the circumstances accompanying the performance of those duties are so various, that it is scarcely possible, and it is certainly not probable, that electricians will ever agree upon one general criterion," &c. This argument I cannot follow. Which are the duties or circumstances in connection with dynamos that would make a determination of the economic value of the machines useless or unimportant. It reminds me of a theory I heard some two years ago about train-lighting: the expenses for coal being unimportant because the dynamo was driven off an axle in one of the carriages.

As for the name, "the effective strength of magnetic field" would be all right for magnetos, but for ordinary dynamos the coefficient is $F \times \frac{w\,a}{w\,a + w\,m}$. "Electrical merit" is a well-known expression for the reciprocal of the current required in a galvanometer to produce a certain effect. The similarity of the two cases led me to adopt this term.

One question to Mr. Moon: If I publish some, as I believe, new formulæ "for use in constructing dynamos," and somebody brings up a formula which is not of similar use, saying it is simpler, is it then really irrelevant to remind this gentleman of the purpose of my formulæ?

F. V. Andersen.

I should like to draw Mr. Andersen's attention to his standard resistance of pure copper as given on page 389 of November 7th.

Quoting Dr. Matthiessen, he states that the resistance of one mile of pure copper wire $\frac{1}{16}$ inch diameter at a temperature of 15·5° Cent., is 13·59 ohms.

Now, in Dr. Matthiessen's table giving the resistances of the foot-mil., foot-grain, &c., of pure metals, as published in the various text books; the resistance of a wire of pure annealed copper at 0° Centigrade, one foot in length and $\frac{1}{1000}$th inch diameter, is given as 9·718 ohms.; correcting this to the dimensions of Mr. Andersen's standard, we get

$$9{\cdot}718 \times \frac{5280}{(62{\cdot}5)^2} = 13{\cdot}1356 \text{ ohms. at } 0° \text{ C.}$$

using Mr. Matthiesson's formula to correct for the difference in temperature, viz.,

$$R = r\,(1 + a\,t \pm b\,t^2)$$

in which R = the resistance at required temperature;
r = the resistance at given temperature;
a = a constant number = + ·0003824;
b = a constant number = + ·00000126;
t = number of degrees (Cent.) difference between the two temperatures;

then R = 13·1356 (1 + ·0003824 × 15·5 + ·00000126 × (15·5)²) = 13·918 ohms, or about 2¼ per cent. higher than the value given by Mr. Andersen.

Gnan.

December 15th, 1885.

Elieson's Electric Tramcar System.

My attention having been drawn to a paragraph in your last issue *re* the Elieson Electric Locomotive Car, wherein a parenthesis occurs, which it was asserted must apply to me, I beg to inform you that my initials are "M. H. S.," and that I never write without appending my full name.

I have seen the Elieson car, but hitherto have refrained from expressing any opinion concerning it. I have not seen the letter of "H. S."

If, however, it would be of interest to your readers, I shall be pleased to give you a report of my inspection and my conclusion thereon.

M. Holroyd Smith.

Halifax, *December 14th*, 1885.

[From Mr. Smith's connection with another system, we fear that his judgment might not, by some, be deemed impartial. We, however, thank him for his offer.—EDS. ELEC. REV.]

ARCHIMEDES REDIVIVUS.—"Hiero," the author of some excellent lines having the above title, does not reveal his name and address. It is against our rules to insert anonymous communications.